A Quarter Acre Pavlova Paradise Lost?

The Role of Preferences and Planning in Achieving Urban Sustainability in Wellington, New Zealand

by

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Abstract

This thesis investigates the scope for compact development to accommodate population growth in Wellington, New Zealand. The topic is particularly significant for New Zealand as the great majority of the population lives in urban areas, historical development has been dominated by low density urban form, and transport and urban form are two of the main domains in which the country can reduce its carbon emissions. The influence of urban planning and residents' preferences on achieving sustainable outcomes is investigated.

Historical and current planning rules and transport policies in the City are analysed to determine their influence on the provision of compact development. Wellington's transport policy shows a pattern of path dependency: historical decisions to favour car oriented investment have driven subsequent transport investments and influenced the ease of using different transport modes. Planning policies show a similar pattern of path dependency: planning rules enacted in the 1960s endure in present planning despite being packaged with different justifications and regulatory regime. Current planning rules severely restrict infill development in most existing neighbourhoods, which reduces the availability of housing in accessible medium density neighbourhoods and likely increases the cost of this type of housing.

A stated choice survey was conducted of 454 residents of Wellington City to investigate the extent to which there is an unmet demand for compact development and alternatives to car travel. The survey held presentation mode constant across two completion modes (internet and door to door with tablet completion), allowing the impacts of recruitment and completion mode to be examined. Survey recruitment mode appeared to influence both response rates and the representativeness of the survey, while completion mode appeared to have little or no impact on survey responses.

Using the stated choice survey results, a latent class model was developed to examine the preferences of residents and the trade-offs they are willing to make when choosing where to live. This type of model allows for the identification of preference groups as a means of understanding the diversity of preferences across the population. The study found that there is an unmet demand for medium density, accessible housing, but that affordability is a barrier for households to choose this type of housing. There was also an unmet demand for walking and cycling, with more residents currently driving than would prefer to use this mode, and more residents preferring to walk and cycle to work than currently use these modes. The ability to use a desired travel mode appears to be related to the neighbourhood in which a person lives, with residents of medium and high density neighbourhoods being more likely to use their preferred travel mode.

This study also modelled future development trajectories for Wellington based on demand for housing, neighbourhood and transport attributes. This preference based growth model was contrasted with the City's plan for development over the next 30 years. Comparing the two scenarios, the planning based trajectory performed better than the demand based scenario in terms of both carbon emissions and achieving compact development.

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List of Abbreviations

CAU	Census area unit
CBD	Central Business District
DCE	Discrete choice experiment
DPC	District Plan Change
EU	European Union
GHG	Greenhouse gas emissions
LCA	Latent class analysis
LGA	Local Government Act
MBIE	Ministry of Business, Innovation, and Employment
MDRA	Medium density residential area
MNL	Multinomial logit model
NZTA	New Zealand Transport Agency
OECD	Organisation for Economic Cooperation and Development
PP/HA	Persons per hectare
RMA	Resource Management Act 1991
SCS	Stated choice study
VKT	Vehicle kilometres travelled
WCC	Wellington City Council
WTP	Willingness to pay

CHAPTER 1

INTRODUCTION

1.1 The problem

Urban population growth

New Zealand is one of the most urbanised countries in the world, with over 85% of its population currently living in urban areas (Statistics New Zealand, 2004; Statistics New Zealand, 2013). New Zealand is expected to continue a pattern of increasing urbanisation; the majority of future population growth is expected to be accommodated in main urban areas, and to be particularly concentrated in the country's three largest urban areas: Auckland, Christchurch, and Wellington (Statistics New Zealand, 2012). The means by which urban areas accommodate future population growth will have critical impacts on both the lived experience of urban dwellers in New Zealand and the local and global environment. For urban dwellers, urban form is recognised to have a significant influence on the lived experience; it plays a key role in determining travel modes and distances travelled, influences the types of dwellings available, affects access to outdoor space and recreational opportunities, and influences health factors such as exposure to air emissions and physical activity levels. Urban form impacts the local environment by shaping the percentage of total land dedicated to urban development, accessible green space, local air quality and temperature, and the health of local water bodies. Urban form impacts the global environment by playing a key role in determining the greenhouse gas (GHG) emissions from cities; it influences GHG emissions from transport as well as energy use within commercial and residential buildings.

Social and political context

New Zealand is at a critical juncture in determining how its urban areas will develop in the coming century. For several decades, 'the quarter acre dream', ownership of a standalone home on a large section in the suburbs, has been seen as an aspiration for most, if not all, New Zealand families. This was reflected in the title of Austin Mitchell's book, *the Half Gallon Quarter Acre Pavlova Paradise*, and the term has since been incorporated into the country's vernacular (Orsman, 1997). Throughout the 20th century, this aspiration was reflected in the spatial form of New Zealand cities. Standalone homes on sections were the principal residential development type, with cities experiencing an outward growth pattern and expanding urban limits. However, the viability of the quarter acre dream has been called into question as increased urbanisation and population growth encounter higher oil prices, and environmental and social constraints. Under medium range projections, the population of the Auckland region is currently expected to grow 40% by 2031, while the Wellington and Christchurch regions are expected to grow by 15% and 19% respectively (Statistics New Zealand, 2015). In Auckland and Wellington cities, multi-unit dwellings have

replaced standalone dwellings as the principal residential development type for new construction since 2012 and are expected to be the principal housing type built to accommodate future population growth (Haarhoff et al., 2012; Hinton, 2013). However, it remains to be seen if this shift in development patterns is due to a genuine change in the aspirations and preferences of New Zealanders, a response to escalating housing prices due to increasing demand and limited supply, or both. Housing has become increasingly unaffordable in New Zealand; from 1990 to 2010 the house price to disposable income ratio more than doubled and the rates of home ownership fell significantly (The New Zealand Productivity Commission, 2012). At the same time, evidence suggests that preferences are shifting; a large minority of people under 35 have stated a preference for a shorter commute over a larger house and outdoor space (Preval, Chapman, & Howden-Chapman, 2010).

In response to recent concerns over housing prices, the central government has taken an active role in the planning process, commissioning several reports on housing affordability and intervening in the urban planning process at a local government level (Department of Internal Affairs, 2013; O'Fallon & Wallis, 2012b; Smith, 2013; The New Zealand Productivity Commission, 2012). This appears to be not only due to a concern about asset price inflation and housing affordability, but also due to a concern for the future of the quarter acre dream. In the context of Auckland's growth plan, the central government has focused not only on housing affordability, but also an ample supply of greenfield land for the development of standalone dwellings ("John Key - Auckland's unitary plan," 2013, Ministry of Business, Innovation and Employment, 2013; Smith, 2013).

While the central government has been primarily targeting housing supply and affordability, city and regional councils throughout New Zealand are attempting to manage urban growth in the context of their own planning and policy agendas. These include fulfilling a wide range of objectives, such as reducing GHG emissions, the sustainable management of natural and physical resources, sustaining economic growth, maintaining heritage and character, creating liveable cities, and respecting the preferences and opinions of residents. Auckland's Unitary Plan sets forth the ambitious goal of becoming 'the world's most liveable city', while also protecting the environment, creating sustained economic growth, reducing inequality, and creating a world class transportation network (Auckland Council, 2012). Wellington's District Plan sets forth a vision for a more sustainable city, with sustainability encompassing environmental, social, and economic well-being (Wellington City Council, 2012). Wellington City is also attempting to become a global leader in the realm of urban sustainability and resilience, participating in the UN-Habitat City Resilience

Profiling Programme, the global Biophilic Cities Project, and the 100 Resilient Cities Programme (Biophilic Cities, 2013; Wellington City Council, 2013b).

However, these ambitious goals can often be in conflict with one another or with central government agendas. In both Wellington and Auckland, residential intensification has been identified as one of the key means of achieving a liveable urban environment, GHG emissions reductions, and environmental sustainability in a broader sense. However, intensification is often seen to be at odds with economic growth, the preferences of residents, heritage and character, and the transportation requirements of cities. As it is a departure from the historical development pattern and planning policies, intensification often requires extensive changes to planning regulations in order to be converted from policy aspiration into practice.

Greenhouse gas emissions

There is now overwhelming evidence that anthropogenic GHG emissions are contributing to the warming of the earth's air and oceans, and that this warming will have severe adverse impacts on the well-being of both humans and ecosystems across the globe (IPCC, 2007; Parry, Canziani, Palutikof, Van der Linden, & Hanson, 2007). Like most other developed nations, New Zealand has committed to substantially reducing its GHG emissions over the next century. New Zealand has committed to a short term target of a 5% GHG emissions reduction by 2020 (relative to 1990 levels) and a long term target of a 50% GHG emissions reduction by 2050 (Groser, 2013; Ministry for the Environment, 2011). This reflects a global consensus on the scientific basis of anthropogenic climate change and the catastrophic implications of global GHG emissions under a business as usual emissions scenario. However, the 2007 Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) implies a need for more drastic emissions reductions in order to not exceed 2.0-2.4 degrees C of warming above pre-industrial levels, suggesting that industrialised nations will need to make emissions reductions of 80 to 95 per cent by 2050. This is reflected in the emissions reductions commitments of EU nations, who have committed to ambitious short and long term reductions. Regardless of whether New Zealand ultimately adopts more drastic emissions reductions targets or continues with its current commitments, GHG emissions will need to be substantially reduced across key emissions categories in order to meet reduction goals, including major cuts in transport, energy, manufacturing and construction, and agriculture.

Transportation plays a critical role in generating greenhouse gas emissions in New Zealand, where a large majority of the population lives in urban areas and emissions from electricity generation are

relatively low as compared to other OECD nations. Road transportation contributes 18.2 per cent of gross GHG emissions in New Zealand, substantially larger than the OECD average of 10.7 per cent (OECD, 2010). Road transportation is also largely responsible for the country's increase in GHG emissions from 1990 to 2009, as it was the single fastest growing emissions category, increasing by 69.7 per cent during that time period (Ministry for the Environment, 2013).

Transportation related emissions have been described as a 'three-legged stool' with three principal components: the number of vehicle kilometres travelled (VKT), vehicle fuel efficiency, and the carbon content of the fuel consumed (Ewing, Bartholomew, Winkleman, Walters, & Chen, 2007). In New Zealand, growth in GHG emissions from transport from 1990 has been largely due to a substantial overall increase in overall VKT. VKT has increased because of two main factors: an increase in the driving age population as well as the average number of vehicle kilometres travelled per capita. There is, however, modest evidence of a shift in this trend since 2008. Total road VKT remained constant between 2008 and 2012, while VKT per capita decreased by 3.2 per cent during the same time period (Ministry of Transport, 2013b). The fuel economy of the New Zealand light vehicle fleet has remained relatively flat, hovering around 10 litres per 100 kilometres travelled from 2001 to 2012 despite a modest increase in the fuel economy of new vehicles entering the vehicle fleet (Ministry of Transport, 2013a). Vehicle fuel types have remained virtually unchanged in New Zealand; petrol and diesel fuelled vehicles constitute 99.95 per cent of the vehicle fleet and although bioethanol-blended petrol became available in 2007 it has yet to be widely incorporated into the available fuel supply (Energy Efficiency and Conservation Authority, 2013; NZ Transport Agency, 2013).

It is widely accepted that denser urban form, characterised by mixed use development and high-quality transportation networks, can play an important role in reducing VKT. Compact urban form lowers transportation VKT in a number of ways; it shortens trip length, makes public and active transport more viable, and allows for fewer trips since multiple journeys can be combined (Ewing et al., 2007; Kenworthy, 2007). While urban dwellers generally have lower carbon emissions than rural dwellers, emissions among urban dwellers vary greatly, with urban form being a primary determinant of this variance (Dodman, 2009; Kenworthy & Inbakaran, 2011). This variance is clearly observable within a New Zealand context. In the Auckland metropolis over two thirds of people travel to work by car, while in the comparatively denser Wellington region only half of commuters travel to work by car (Statistics New Zealand, 2009). Compacting urban form has been proposed as a particularly desirable component of New Zealand's strategy to achieve its long term GHG emission reduction goals as it plays a significant role in determining VKT (Chapman, 2008).

Co-benefits

Urban form is a promising area for reducing transport related GHG emissions as it is not only a determinant of residential GHG emissions but can also provide many co-benefits that are desirable regardless of emission reduction benefits (Chapman, 2008; Haines et al., 2009; Woodcock et al., 2009). These co-benefits include improving health outcomes through increased physical activity and decreased air pollution; retaining land for alternative uses such as farmland, recreational space, and wildlife conservation; improving air and water quality; reducing the cost of infrastructure service provision; and lowering transportation costs for consumers (Carruthers & Úlfarsson, 2008; Chapman, 2008; Frank et al., 2006).

The rise of obesity and physical inactivity in New Zealand is widely seen as a major public health problem, and the decline of active transportation is recognised as a contributing factor. It has been well demonstrated internationally that time spent walking and cycling significantly decreases the odds of being obese, while time spent driving increases the likelihood of obesity (Frank et al., 2006; Frank, Andresen, & Schmid, 2004). The built environment is recognised to be a key determinant of these transport behaviours. In the past decade public health research has identified the urban built environment as a key component of the obesogenic environment, which is described as “the sum of influences that the surroundings, opportunities, or conditions of life have on promoting obesity in individuals or populations” (Kirk, Penney, & McHugh, 2010, p. 1; Lake & Townshend, 2006). In a New Zealand context, the built environment has been shown to be strongly associated with both transport and leisure physical activity (Witten et al., 2012). In recent decades, active transport rates have been declining, suggesting negative health outcomes for both adults and children; between 1990 and 2008, 25% more primary school children were driven to school rather than biking or walking, while 10% more adults drove to work rather than biking, walking or carpooling (Keall, Chapman, & Howden-Chapman, 2010; Ministry of Transport, 2009).

Air pollution from motor vehicles is a significant problem in New Zealand, and is estimated to be responsible for over 250 premature deaths and around \$1 billion in social costs per year (Kuschel et al., 2012). Evidence suggests that urban form plays a role in both determining emissions from motor vehicles and levels of exposure to air pollution. Mixed land uses, higher density, and greater street connectivity are associated with significantly lower per capita emissions of nitrogen oxides and volatile organic compounds when controlling for income, age, vehicle ownership, and household size (Frank & Engelke, 2005; Frank et al., 2000; Frumkin et al., 2004). Chronic exposure to air pollution has been shown to vary both within areas of cities and between cities, suggesting

that urban form plays a significant role in determining exposure to urban air pollution (Marshall et al. 2005). Transport and land use policies which increase levels of active transport and decrease motor vehicle use have been suggested as a viable means of decreasing GHG emissions as well as improving health outcomes (Hosking, Mudu, & Dora, 2011; Lindsay, Macmillan, & Woodward, 2011; Woodcock et al., 2009).

Urban development patterns can also influence government expenditure on infrastructure provision, such as water, sewerage, roading, public transport, and emergency services. International evidence indicates that low-density residential development distant from city centres is more costly to provide services for than more central and high-density development (Burchell & Dolphin, 2009, 2009; Carruthers & Ulfarsson, 2003; Centre for International Economics, 2010; Hortas-Rico & Solé-Ollé, 2010; Trubka, Newman, & Bilsborough, 2008). As infrastructure costs are typically borne by local governments and may be assessed on a city-wide basis, the full cost of residential development at the urban periphery may not be internalised into housing costs. This can create a market distortion which artificially encourages dispersed residential development patterns, as the full cost of new residential development is not borne by the consumer but rather the community at large (Brueckner, Mills, & Kremer, 2001). Increasing residential density and placing limits on urban expansion have been suggested as means of decreasing the cost of public service provision, as well as increasing equity among ratepayers.

The amount of land dedicated to urban development impacts the amount of land available for alternative uses, such as farmland, recreational space, ecological conservation, and watershed protection. This is particularly a concern for countries with rapidly expanding urban populations and/or limited amounts of land. For example, in the United States there has been substantial concern over the loss of agricultural land due to urbanisation, and a desire for the preservation of agricultural land has been a key factor in controlling urban expansion through measures such as intensification and metropolitan urban limits (Alig, Kline, & Lichtenstein, 2004; Ewing, 2008). Although urban areas constitute less than 3 per cent of New Zealand's land area, some have called attention to the loss of agricultural land due to urbanisation and peri-urban lifestyle blocks (Andrew & Dymond, 2013).

1.2 Solutions to the problem

A wide body of research suggests that compact, transit oriented urban development is desirable due to its many advantages over more dispersed development patterns; these advantages include reduced greenhouse gas emissions, a reduction in private and public transport costs, reduced localised air emissions, increased physical activity levels, decreased cost of public service provision, and preservation of open space or valuable agricultural land. Despite the advantages of compact growth, urban areas in developed countries have largely decreased in density and have followed a pattern of outward expansion over the last century (Huang, Lu, & Sellers, 2007), and some have argued that compact development is very difficult, if not impossible, to achieve in practice due to systemic barriers (Downs, 2005). Some have argued that low density, sprawling growth patterns provide benefits that at least partially justify this pattern of growth, such as increased living space and quality of living (Glaeser & Kahn, 2003), decreasing housing costs and increasing affordability (Downs, 2004), meeting consumer preferences (Gordon & Richardson, 1997), and preserving the character of existing neighbourhoods by minimising the externalised costs of intensification (Fischel, 2009).

Many cities across Europe, North America, and Australia have decided that a compact development pattern is worthwhile and have adopted a number of different strategies for managing urban growth in order to achieve the desired social, economic, and environmental outcomes that accompany compact development. These include, but are not limited to: methodological changes in land use and transport planning, and the introduction of new urbanist and smart growth principles into the urban planning field.

On a methodological level, there has been a widespread recognition of the value of integrated land use and transport modelling. This recognition has extended to incorporating such integrated modelling into planning practice. This is due to the understanding that transport investments drive land use change and land use patterns influence transport patterns, as well as a concern for the environmental and social impacts of motor vehicle use (Commission for Integrated Transport, 2006; European Commission, 2003; OECD Global Science Forum, 2011).

New urbanism is an American approach to urban planning which seeks to reduce automobile dependence through neo-traditional town planning principles, such as pedestrian-oriented town centres, mixed density zones, and interconnected streets (Falconer, Newman, & Giles-Corti, 2010; Roseland, Mark, 2005).

Smart growth is a wider set of urban planning principles designed to avoid sprawl and its perceived negative consequences. It has received widespread support from government and nongovernment bodies, including the American Planning Association, the US Environmental Protection Agency, the US Department of Transport, and many US State and local governments. The most commonly accepted principles of smart growth include:

- Limit the outward expansion of residential development in order to make development more compact.
- Increase residential densities in new and existing neighbourhoods.
- Increase the mix of land use uses to increase destination accessibility and incentivise active transport modes.
- Internalise the costs of new development into the cost of housing so it is borne by the consumer rather than the community at large.
- Increase the use of public and active transport rather than private motor vehicles.
- Revitalise older existing neighbourhoods rather than building new ones (Calthorpe, 2010; Daniels, 2001; Downs, 2005; Ewing, 2008).

In the United States, public policy instruments for managing urban growth are extensive at the local and state government level; these include but are not limited to state-wide smart growth ordinances, the development of smart growth zoning tools, development impact fees, urban growth boundaries, and transfers of development rights for open space (Bengston, Fletcher, & Nelson, 2004; Talen, 2009).

In Australia, many cities have taken active steps to move towards a sustainable development pattern by encouraging intensification, implementing new urbanist principles, and investing in sustainable transport modes. The Western Australian State Government has developed the Liveable Neighbourhoods programme, an urban planning code based on new urbanist principles, invested in an expansive railway network, and integrated land use and transport in its planning process (Curtis, 2011; Falconer et al., 2010; Martinovich, 2008). Cities such as Melbourne and Sydney have committed to the goal of intensification, and are attempting to accommodate the majority of future population growth through medium and high density housing development in existing urban areas (Buxton & Tieman, 2005; Centre for International Economics, 2010; Searle & Fillion, 2011).

Sustainable urban development in New Zealand

Efforts at implementing sustainable urban development are in their early stages in New Zealand. Central, regional and local governments have all demonstrated interest in sustainable transport and urban development; however this has for the large part yet to be translated into planning policy and practice.

From 1999 to 2008, New Zealand had a Labour-led central government which viewed sustainable development as a priority on its political agenda. During this time period, various reports and discussion papers were written on the topic of sustainable urban development. In 2003, the Government released *Sustainable Development: A Programme of Action for New Zealand*, which identified the importance of city liveability, and cities as centres of innovation and economic growth. Removing impediments to medium to high-density housing and high quality transport networks were emphasised. The New Zealand Urban Design Protocol was launched in 2005 with the objective of improving the quality of urban development in New Zealand. The Protocol is a voluntary agreement whereby signatories, including local government, private companies, and various institutions commit to quality urban design principles which support liveable urban environments. By 2013, the Protocol had over 180 signatories, including all city councils in New Zealand.

Land use planning in New Zealand is set within the statutory context of the Resource Management Act of 1991 (RMA), as well as the Local Government Act of 2002 (LGA). While the objective of the RMA is to “promote the sustainable management of natural and physical resources”, the means by which this is achieved with regard to urban planning is largely at the discretion of local government. The RMA set forth an effects-based planning regime, whereby the permissibility of activities and land uses is determined by local government authorities in order to achieve the desired outcomes. Land use control is principally achieved through District Plans, and any land use or activity can be permitted so long as the adverse effects on natural and physical resources are avoided, remedied, or mitigated to a sufficient extent (Memon & Gleeson, 1995). Urban transport planning in New Zealand is set within the Land Transport Management Act of 2003, which requires the creation of national as well as regional land transport strategies.

One of the largest obstacles for sustainable urban planning in New Zealand is the statutory separation between transport and land use planning. While it is well known that land use and transport patterns are interconnected, there is no binding requirement or institutional framework for integration between land use and transport planning. As a result, these two factors have tended

to influence each other in an unplanned rather than a strategic fashion, and land use and transport investments are integrated - to a greater or lesser extent - between national government, regional and local government at the will of policymakers, rather than due to statutory requirements (Knight-Lenihan, 2013).

Local governments throughout New Zealand have demonstrated a concern for sustainable urban development through actions such as changes to their transport and planning strategies and becoming signatories to the Urban Design Protocol. The largest urban areas have made commitments to residential intensification and investments in sustainable transport. However, there has yet to be a large scale transition to sustainable urban development in practice; cities are still largely reliant on the private motor vehicle for transport, and by and large continue to exhibit an outward growth pattern.

Creating a 'sustainable city' and reducing urban GHG emissions is not just a matter of technical feasibility; it also requires the involvement of the public at large. From a policymaking perspective, a substantial shift in urban policy requires the support, or at least the acquiescence, of the voting population. A change in urban form and transport structure also requires behavioural change from residents; individuals will need to live in denser neighbourhoods and adopt alternatives to car travel. While it is widely agreed that urban form is correlated with travel behaviour – those living in denser neighbourhoods drive less than their counterparts in less dense neighbourhoods – there is less agreement on the causality of this relationship (Levine & Frank, 2007a; Mokhtarian & Cao, 2008a). If urban form is the primary driver of transport behaviour, then relocating individuals from less to more dense neighbourhoods will result in decreased GHG emissions from transport, but if travel preferences are the primary driver, and if residents 'self-sort' into neighbourhoods according to their travel preferences, suburbanites would bring their car driving habits with them even if relocating to dense neighbourhoods (Mokhtarian & Cao, 2008a). Therefore, precipitating changes in travel behaviour through a change in urban form is predicated on understanding individual decision making and preferences regarding neighbourhoods and travel modes. Knowledge of the public's neighbourhood and housing preferences is key to facilitating changes in urban form while still ensuring that the city remains a place that people want to live in. This thesis, accordingly, is an investigation into the human element of transitioning to a sustainable urban form. It investigates the extent to which the housing, neighbourhood, and travel preferences of New Zealanders will impact the future growth trajectories of cities, using Wellington City as a case study.

1.3 Wellington case study

Wellington City is a desirable case study for reasons of urban geography as well as political and social context. Although only 41% of the Wellington region's population currently lives in Wellington City, Wellington City is expected to accommodate 71% of the region's growth from 2013 to 2043 (Statistics New Zealand, 2015). The City has the highest levels of public and active transport in New Zealand, and relatively high levels of density, placing it at the forefront of New Zealand cities in terms of a transition to a low carbon transport network (Nunns, 2014a; Statistics New Zealand, 2009). However, despite impressive numbers in relation to other cities such as Auckland, there is still substantial room for improvement in urban form and travel behaviour in Wellington, improvements which must be made if the country's long term emission reduction goals are to be met.

Residential intensification has been identified as a key component of the City's growth strategy, and is a key means of achieving the city's goals for a liveable urban environment, GHG emissions reductions, and shifts towards sustainable transport modes. This strategy has been remarkably successful in reorienting the city's growth pattern; Wellington's inner city population has grown by an estimated 500 per cent since 1990 and multi-unit dwellings in existing neighbourhoods have replaced standalone dwellings as the most common development type. However, intensification in Wellington has almost exclusively taken place through high density residential development in the form of inner city apartments. High and medium density housing types continue to be viewed negatively under the current planning regime; low density detached dwellings with private parking are viewed as the ideal housing type in the eyes of planning documents¹. Evidence suggests that inner city apartments may be at odds with the housing preferences of many residents for various reasons, such as a lack of outdoor space, and a limited range of dwelling sizes in the inner city (Morrison & McMurray, 1999). Inner city apartments disproportionately cater to individuals in the 20-35 age group, whereas low density housing in the suburbs still appears to be aspired to for long-term living, especially among those with children (Howden-Chapman, Hamer-Adams, Randal, Chapman, & Salmon, 2015; O'Fallon & Wallis, 2012b).

Medium density housing development has been proposed by Wellington City Council as an additional means of achieving residential intensification. As opposed to high density inner city development, medium density housing development has the potential to cater to a wider variety

¹ Refer to Chapter 2 for discussion of urban planning in Wellington City.

of households by providing some of the attributes which are common to standalone homes in low density areas. However, this approach has been met with considerable resistance from the public.

This thesis is an investigation into the potential for medium and high density housing to accommodate future population growth and reduce GHG emissions from transport in Wellington. It investigates how preferences relate to housing and neighbourhood choices, and the extent to which preferences can facilitate or hinder a transition to a sustainable urban form. Understanding this relationship can inform the future potential of a transition to denser cities overall.

1.4 Objectives of the study

This research addresses the following question: What is the potential for residential intensification in Wellington City?

Sub questions:

- How does the current planning regime influence Wellington City's growth trajectory?
- What is the latent demand for alternative housing development patterns in the City?
- How do residential preferences and housing choice influence travel patterns and carbon emissions in the City?
- What are the carbon emissions implications of alternative development patterns for the City?

1.5 Structure of this thesis

Chapter 2 discusses the planning context of urban development in Wellington City.

Chapter 3 reviews the literature on smart growth, travel behaviour, housing and neighbourhood preferences, and greenhouse gas emissions.

Chapter 4 contrasts digital survey techniques and discusses the relative merits of door to door and online survey methods.

Chapter 5 discusses the theory of stated choice studies, sets forth a framework for analysis, and presents the results of a stated choice survey.

Chapter 6 describes and analyses the results from the growth scenarios model and discusses these results.

Chapter 7 analyses the potential impacts of growth scenarios on greenhouse gas emissions, density, and affordability

Chapter 8 summarises key conclusions, discusses the limitations of the study, and suggests directions for future research.

CHAPTER 2

PLANNING IN WELLINGTON AND ITS IMPLICATIONS

2.1 Introduction

This chapter first reviews the legislative context for urban planning in New Zealand and provides an overview of the historical patterns of urban development in Wellington City. It then examines the plans and strategies that form the current spatial planning context within the City and discusses their implications for the City's growth trajectory and its objective of achieving sustainable urban development.

2.2 Conceptual framework

Arguments for compact, mixed-use development usually rely on theoretical principles and empirical evidence of their environmental and economic benefits to society at large. Transportation related benefits have received particular attention from the academic community, both within New Zealand and internationally (Chapman, 2008; Ribeiro et al., 2007; Woodcock et al., 2009). These include potential reductions in greenhouse gas emissions and localised air pollutants from reductions in vehicle kilometres travelled, and increased walking and cycling rates, which in turn result in increased physical activity and positive health outcomes. Most of these analyses presume, either implicitly or explicitly, that deviation from the current 'business as usual' development and transportation pattern is justified only if empirical analyses demonstrate that the intervention would result in the environmental and economic benefits stated (Levine & Frank, 2007). Compact, mixed use development is seen as a justified market intervention which corrects market failures such as environmental and economic externalities, and research attempts to quantify the extent of these externalities. For example, a 2012 study funded by the NZ Transport Agency attempted to quantify the extent to which dense urban environments decreased vehicle kilometres travelled (VKT) and increased active transport in Auckland and Wellington (O'Fallon & Wallis, 2012b). The study determined that while inner city residents did drive significantly less than their suburban counterparts, "it could be said that their attitudes are an important determinant of their mode use, rather than the built environment, although the built environment facilitates residents to actively demonstrate their favoured travel and vehicle ownership behaviours" (O'Fallon & Wallis, 2012, p. 2). The implication is a conservative one - that a move from a dispersed development pattern to a more compact one may be unwarranted in Wellington and Auckland, as travel preferences, rather than the built environment, are implicitly seen as the primary determinant of travel patterns in the two cities.

If attitudes and preferences, rather than the built environment, are the primary determinant of travel behaviour, then is a shift to an intensified urban form warranted? If there is insufficient

evidence of transport related benefits, then dispersed development is often the default option of choice, as it is assumed to be the result of market forces of supply and demand. In the New Zealand context, Prime Minister John Key espoused this view while voicing his support for an expansion of the Auckland metropolitan limit, stating that “it is a supply and demand issue” and “I don’t think people do want [the high rise look and feel] in Auckland” (John Key - Auckland’s unitary plan, 2013).

An alternate framework for analysis is to question whether current development and transportation patterns are indeed the result of market forces, and thus an accurate reflection of consumer preferences. Many studies of this type utilize stated preference studies as an alternative to revealed preference studies in order to ascertain consumer preferences, while other studies focus on market distortions, such as zoning restrictions, subsidies, and government transportation investments that limit what can be built and thus the extent to which preferences can be realised in the marketplace. For example, Levine (2006) argues that within the North American context, low density, outward growth patterns are largely the result of zoning regulations that limit development densities and separate land uses. This chapter adopts this latter approach and investigates how and to what extent City plans and policies are a driver of land use and development patterns, rather than private market forces.

2.3 Legislative context for planning in New Zealand

New Zealand’s first planning statute was the Town Planning Act 1926, which arose both due to the emergence of the town planning movement in Britain and out of concerns over rapid urban growth rates and slum-like conditions in many urban centres in New Zealand. The Act introduced the concept of zoning to the country, and required areas to be designated for specific purposes or classes of purposes. Although the Act required authorities with a population of over 1,000 to prepare town plans, it was largely ineffective at achieving local government control of urban development patterns. By 1953, only one city had an approved plan and two more had provisionally approved plans. While these plans were to be prepared by local bodies, the central government reserved the authority to approve and maintain the schemes. Resistance to central government control was likely a primary reason for limited uptake of town plans (Perkins, Memon, Swaffield, & Gelfand, 1993; Productivity Commission, 2015).

The Town and Country Planning Act 1953 introduced a more politically acceptable planning regime whereby local bodies retained greater control over the planning process. The Act required every municipality to create, maintain, and implement a district planning scheme that made

provisions for land use zoning, the preservation of open space, land subdivision, and the control of building heights and densities (Perkins et al., 1993; Productivity Commission, 2015). While the Act enabled local governments to extensively control urban development, Perkins et al. (1993) argue that local governments had little desire for extensive intervention and instead preferred a *laissez faire* approach to planning. The Town and Country Planning Act 1977 was an attempt to modernise planning in New Zealand and incorporated aspects of planning philosophy from the US and the UK. It also allowed for more flexibility through discretionary ordinances and accommodated greater public participation by permitting any affected person or body to object to a scheme or planning application (Memon & Gleeson, 1995; Productivity Commission, 2015).

Current District Plans in New Zealand are required under the Resource Management Act of 1991 (RMA), which calls for the sustainable management of natural and physical resources and mandates statutory requirements for planning documents. The RMA set forth an effects-based planning regime, whereby the permissibility of activities and land uses is determined by local government authorities in order to achieve the desired ‘effects’ or outcomes. Constraints on land

Figure 2.1: Wellington City 1840, with 2016 as a reference point

Source: Felton, 1841 and Google, 2016

use are expressed in the District Plans created by territorial authorities. District Plans are required to set out which activities are permissible within given geographic areas, as well as the conditions which must be met in order for activities to be deemed permissible. Under the RMA, any land use or activity can theoretically be permitted so long as the adverse effects on natural and physical resources are avoided, remedied, or mitigated (to a sufficient extent). Unlike previous legislation, the RMA does not have an explicit urban planning focus; rather it applies the same resource consent process that is used for other activities with environmental impacts to the urban planning context. As a result, requirements for District Plans focus on minimising local environmental impacts and neglect social goals, such as achieving a liveable urban environment, which tend to be considered separate matters addressed under the Local Government Act 2002 (Memon & Gleeson, 1995; Perkins & Thorns, 2001). The RMA also mandates extensive public participation and consultation throughout the planning process. This includes a requirement for Councils to consult with specific people and groups and the ability of people and groups to make submissions on plans and proposed plan changes, be heard at Council meetings, and to appeal planning decisions to the Environment Court (Productivity Commission, 2015).

2.4 Development without planning, 1840 – 1945

The Wellington area was settled by numerous Maori Iwi from the 12th to the 19th century, and the central city was the location of two villages, the Te Aro Pa and the Pipitea Pa, upon European arrival. At the time, the primary building material was tree fern trunks and the majority of land in the central area was dedicated to farming, and also consisted of marshlands which were used for shellfish collection (Love, 2012). Wellington City was settled privately by the New Zealand Company in 1840, in cooperation with the English government. The company implemented a grid based street pattern ringing the Wellington harbour surrounded by a town belt, as both planning elements were fashionable in Britain at the time (Productivity Commission, 2015). The original plan for Wellington consisted of 1,100 town acre (0.4 hectare) lots within the town belt (Figure 2.1). The areas developed were the flattest and most proximate to the harbour, and thus most desirable parcels in the City for residential development. The town belt was intended as a site for recreation, a location for public facilities such as hospital, jails, and cemeteries, and to define the spatial extent of urban development and thus support land prices. Victorian wooden and brick buildings dominated early residential development (Yska, 2006).

As the population grew, the city accommodated growth both through the subdivision and intensification of the town acre lots and expansion into greenfield sites beyond the city boundaries (Figures 2.2, 2.3, and 2.4). Rural subdivision was conducted by farm owners and land companies with little government control on the spatial form and density of housing, or the separation of residential from other land uses. However, the Wellington City Council enabled this development through the construction of tram lines to Newtown, Island Bay, Lyall Bay, Kilbirnie, Miramar, Wadestown, and Karori between 1900 and 1929 (Humphris & Mew, 2009). The urban form of these neighbourhoods reflects the dominant transport modes during the periods of their

Figure 2.2: Spatial extent of Wellington City 1841 - 2010

Source: Hinton, 2013

Figure 2.3

Note: Data from prior to 1940 excludes the Maori Population

Source: Statistics NZ, 1865-2013, .ID Consulting, 2011

construction: public and active transport. This translates into neighbourhoods that are oriented towards pedestrians and public transport users, rather than motor vehicles. Parking is predominantly kerbside rather than off street, streets are narrow and interconnected, buildings have prominent street frontages, and retail and commercial areas are located a short distance from would be amalgamated into Wellington City by 1921, although Johnsonville and Tawa would not become part of Wellington City until 1953 and 1989, respectively (Humphris & Mew, 2009; Yska, 2006).

At the same time, the New Zealand central government enabled the growth of the greater Wellington region as commuter ‘dormitory’ suburbs through the introduction of commuter rail service from the region to Wellington City. From 1900, the central government introduced a commuter train to Lower Hutt and Petone with subsidised ‘workman’s tickets’. This allowed for a substantial proportion of the region’s population growth to be accommodated outside Wellington city itself (Evans, 1972). By 1930 the population of Petone and Lower Hutt had grown to 24,135 and 30% of the region’s population was located outside of Wellington City (Statistics New Zealand).

Figure 2.4: Wellington District Plan zones

Source: Author, using GIS data from Wellington City Council

residential areas, often along the main street in each suburb along the historical tram lines (Maclean, 2013). While these suburbs were initially governed as separate boroughs, five of these boroughs would be amalgamated into Wellington City by 1921, although Johnsonville and Tawa would not become part of Wellington City until 1953 and 1989, respectively (Humphris & Mew, 2009; Yska, 2006).

Figure 2.5

Note: Data from prior to 1940 excludes the Maori Population
Source: Statistics NZ, 1865-2013

2.5 Early planning and the rise of automobile dependence, 1945 - 1991

The latter half of the 20th century saw both a rise in land use planning and automobile dependence in Wellington. From 1945 through the 1980s, outer suburbs were the primary location of residential development, and the suburbs experienced sustained growth while the central city residential population dropped by two-thirds (Figure 2.3) (Edridge, 1983; Statistics New Zealand, 2013). During this time the city saw a continued outward growth pattern, a decrease in density, the planning of a major urban motorway, and the removal of the city's tram system. Between 1962

and 1996, driving replaced public transport as the transport mode used by the majority of commuters travelling to work in the Wellington CBD (Dodson & Mees, 2003). This spatial growth pattern was common to many cities during the 20th century, and was accompanied by an increased reliance on the private automobile, a decrease in residential densities, and separation of land uses (Hammer, Stewart, Winkler, Radeloff, & Voss, 2004; Newman & Kenworthy, 1999).

Post-war Wellington saw both a modernisation of the central city as a commercial centre and the increasing suburbanisation of housing. Wooden buildings in the CBD were replaced by steel and concrete office buildings as structural changes in the economy saw an increase in service oriented jobs and an expanding government sector (Schrader, 1996). At the same time, the central city experienced a sharp decline in its residential dwellings and population, and residential development was removed as a permitted use by the City Council (Edridge, 1983). Despite legislation requiring a planning scheme, the City continued to develop without a formal planning department or statutory framework for planning. Controls, such as a prohibition on residential development in the central city, maximum building heights in the CBD, and a near total prohibition on the construction of multi-unit housing throughout the city, were implemented through an informal and undisclosed, un-notified process (Porter, 1970; Yska, 2006).

Significant development of standalone dwellings in the suburbs was led by the central government, which constructed state housing in Miramar, Khandallah, and Strathmore, intended primarily for families with children. Lower income households who were not families were not widely catered for through social housing, and were largely concentrated in the ageing dwellings in the central city (Schrader, 2005). Concerns over poor quality housing and a concentration of poor and non-white residents in Te Aro led the Council engineer to request the central government to pass slum clearance laws. The Housing Improvement Act 1945 allowed the Council to demolish a significant number of wooden dwellings in the central city; this allowed the city to both demolish dilapidated dwellings and to conduct road widening, actions which contributed to the further reduction in the central city population (Gatley, Walker, Skinner, & Clark, 2014; Jeffreys, 1960; Schrader, 1996).

Throughout the 1930s and 1940s, New Zealand's first Labour government further hastened the development of the region through the construction of social housing for low and middle income households. In the 1940s around 3,000 state houses were built in the Hutt Valley. At the same time, railway service to the Hutt Valley was extended and improved, connecting these new developments with commuter service to Wellington City. In 1946 railway service was extended to Naenae and in 1947 railway service was extended to Taita, allowing residents of the Hutt Valley to commute to Wellington City. In the 1950s, New Zealand's first national government continued

the large scale construction of state housing, shifting focus towards increasing the speed of production of houses, reducing the cost of houses, and facilitating home ownership rather than rental housing (Gale, 1994). Between 1950 and 1969, the population of Porirua grew from 1,328 to 26,200, with the vast majority of houses built by the state (Figure 2.5). This housing was predominately in the form of one storey standalone homes on large sections, with design based on British garden city movement principles (Shrader 1999, Evans 1972).

Wellington shifted towards automobile dependence with the removal of the city's tram network and the adoption of a plan to build a major urban motorway. By 1949, the annual number of passengers carried had dropped by almost 9 million from its peak of 64 million in 1944, and cars were widely viewed as the future of transport in the city (Evans, 1972). Maurice Manthel, the owner of the city's largest car dealership, was elected to the City Council after having run on a platform promising to remove the trams and make the city more car friendly. As chair of the transport committee, he presided over the removal of the tram system and its replacement with a bus network, despite the opposition of Mayor Frank Kitts and a public campaign to retain the trams and block the loan necessary to fund the purchase of buses (Hoy, 1970; Yska, 2006). The first tram line was removed in 1949, and the last tram ran in Wellington in 1964 (Hunt, 2013). By 1964, the annual number of public transport passengers had dropped further to 33 million per year (Evans, 1972).

In 1959, Wellington's Chief Engineer, FBC Jeffreys, was sent on an overseas tour of 20 cities to investigate land use and transport planning best practice. In particular, he was tasked to seek solutions to the three main interconnected problems the City Council perceived at the time: an increasing number of central city workers and a resulting pressure on land in the central city, increasing congestion and vehicle registration numbers, and increasing parking demand in the central city and the resulting 'streets clogged with cars' in the absence of any parking management (Jeffreys, 1960, p. 6).

Jeffreys' experience and proposed solutions would have critical impacts on the city's development for decades to come. His recommendations included:

- Transform the central city into a commercial and retail zone by introducing zoning and removing residential as a permitted use. This was in line with planning practice at the time that promoted the separation of land uses through zoning (Talen, 2012).
- Provide for car commuting to the CBD through the construction of Council owned parking garages and street widening along main corridors.

- Introduce minimum parking requirements for residential, retail, and commercial land uses. Jeffreys noted in particular that the US Institute of Traffic Engineers guidelines for demand based parking requirements should be implemented.
- Transition of the inner suburbs to high density apartment living. Jeffreys noted that high density living near the city centre was provided in many overseas cities and that this would enable many people to walk or take public transit to work, and that this strategy would thus reduce traffic congestion.
- The creation of separate town planning and traffic engineering departments at the City Council.

Figure 2.6: The De Leuw Cather Motorway Plan

- Hire an international engineering firm to create a comprehensive transport plan for the city. Jeffreys noted that in overseas cities there is a direct relationship between the proportion driving and the proportion using public transport, and recommended that a transport plan provide for both modes (Jeffreys, 1960).

All of Jeffreys' recommendations were adopted by the City Council. Pursuant to Jeffreys' recommendations, in 1962 an American engineering firm, De Leuw Cather & Company, was hired to create a comprehensive transport plan for the city (Figure 2.6). The plan, which was completed in 1963, consisted of an underground motorway, an underground extension of the extant railway through the CBD to Courtenay Place, a one-way street network, and central city parking garages (De Leuw Cather & Company, 1963; Dodson & Mees, 2003). Both the motorway plan and the railway extension were subsequently adopted in the city's transport plan (Wellington City Council, 1966). The central government fully funded the first sections of the motorway but refused to contribute funding towards the railway extension.

A city councillor at the time, JF Jeffries, noted that because funding from the National Roads Board was only available for motorways, the only means available to City Council to ease traffic congestion was through motorway building, and called for legislation to allow funding to be made available for other transport modes (Jeffries, 1970). The first component of the motorway plan, the Terrace tunnel motorway, was completed in 1978. The De Leuw Cather Motorway plan has continued to strongly influence transport planning in Wellington; subsequent sections from the plan were built in 2006 and 2015, and another proposed section (the Basin Reserve Flyover) was recently rejected by the High Court due to its environmental impacts under the RMA (Dodson & Mees, 2003; New Zealand Transport Agency, 2016; Stewart & Selby, 2007).

Wellington City's town planning department was established in 1965 by Jeffreys in order to create the city's first District Scheme. The first employees were engineers from the city's engineering department. The 1966 District Scheme set forth the following goals for future development:

- *Avoid indiscriminate mixture of incompatible land uses*
- *Economise in the servicing of the District, and*
- *Maintain the stability of individual property values* (Wellington City Council, 1966, p. 2)

The scheme established five zones and the predominant and conditional uses allowed within each zone. The rural zone was set aside as an area for agriculture and forestry, and residential development was extremely limited within this zone. The central city areas of Te Aro and Wellington Central were designated for commercial and retail use only; while existing residences could remain they could not be improved and new dwellings could not be built in the area. The

CBD fringe areas of Thorndon, the Terrace, Mt Victoria, Aro Valley, Kelburn, Oriental Bay, and Newtown were zoned Residential C. These areas were intended for redevelopment as high density apartment living, with densities of 160-240 persons per acre (395 to 593 persons per hectare) permitted. The remaining suburbs were designated Residential Zone A and B. The designated use in these areas was standalone residential dwellings and two-unit dwellings provided they were 'similar in character to that of detached houses in the locality'. 4.5 metre front and 6 metre side setbacks were required, and site coverage was restricted to 40%. A minimum parking requirement of one off-street parking space per residential unit was introduced in all areas. The District Scheme reflected the prevailing wisdom at the time that the strict separation of residential from other land uses increased amenity and preserved standalone home values (Frumkin, Frank, & Jackson, 2004). While the Scheme likely accelerated the decline already occurring in the central city population and enforced a pattern of uniform low density development in outer suburbs, it also allowed for the development of a considerable number of townhouses and medium to high rise apartments in inner suburbs (Figure 2.7). By 1970, 60 percent of new dwellings in the city were in the form of multi-unit housing (Porter, 1970).

A 1979 review of the District Scheme was conducted in accordance with the Town and Country Planning Act 1977. Changes in the scheme reflected the increased role of public participation in the planning process. The scheme responded to both a backlash against the prohibition of central city residential development and the encouragement of high density development in inner suburbs.

Figure 2.7: 1960s suburban development under the District Scheme

Source: Author

The review ended zoning which prohibited residential as a permissible use in the central area and introduced reforms that liberalised shop trading hours and alcohol licensing laws in the central city. Development in inner suburbs was restricted to one and two unit dwellings, with site coverage, height restrictions, and setback requirements similar to those in the outer suburbs (Edridge, 1983; Wellington City Council, 1977).

2.6 Planning under the RMA, 1991 – 2016

Whereas development in the 1980s and 1990s reflected the restrictive 1979 District Plan (the majority of building consents were for standalone housings to be built on greenfield sites on the urban fringe), by 2012 the majority of building consents were for multi-unit dwellings in the central city and inner suburbs (Hinton, 2013; Page, 1996) (Figure 2.3). This shift in the urban development pattern back towards higher density development was made possible by the introduction of a permissive District Plan, created in the wake of the passage of the Resource Management Act of 1991. The new District Plan encouraged the development of apartments in the central city through the removal of the minimum parking requirement in the central city and a temporary tax abatement for office buildings converted to residential use. The plan also allowed infill residential development in inner and outer suburbs with minimal controls (Morrison & McMurray, 1999; Wellington City Council, 2007a). In 1995, the Council removed the resource consent requirement for the conversion of commercial buildings to residential use and removed minimum parking requirements for residential developments in the CBD. Additionally, development contributions for open space were temporarily waived and a one year rates break was offered to new developments, creating an additional incentive to develop in the central area (Morrison & McMurray, 1999; Page, 1996). In the absence of strict planning controls, the Wellington CBD experienced a housing boom; many high rise office buildings were rapidly converted to residential apartments and numerous purpose built residential apartment buildings have been constructed in the following two decades (Morrison & McMurray, 1999; Statistics New Zealand, 2013).

Since 2006, the Wellington City Council has implemented a new Urban Development Strategy and a series of district plan changes in an attempt to replace this liberal planning environment with a more prescriptive planning approach. This new planning approach has three main elements: a containment policy enforced through a metropolitan urban limit, strict limits on infill development, and directed intensification in selected centres.

Wellington's early development was driven by the dominant transport technologies and an urban development approach that encouraged density and containment, resulting in an urban core that

is compact and walkable. Post-1945 development saw the rise of automobile dependence, low density residential development, and a modern urban planning regime, shifts which saw an increase in carbon emissions and the conversion of open land to urban use. This shift was not solely the result of demand given changing transport technology, but was also due to selective transport investments and urban planning rules that encouraged low density development. The period from 1990 to 2009 saw a planning environment that was more tolerant towards high density and infill development, resulting in more compact development, while from 2009 onwards the City has adopted a more prescriptive planning approach (Table 2.1).

2.7 The District Plan

Background

In 2000, the first District Plan became operative and replaced the previous District Scheme, as required under the Resource Management Act, 1991². It is the principal legal document which determines how and where development occurs within Wellington; it not only codifies existing land use patterns but also sets the direction for future changes in urban form and the means of accommodating future population growth. Wellington City's District Plan is an evolving document

Table 2.1: Planning rules over time

	1968 District Scheme	1979 District Scheme	2000 District Plan (as of April 2016)
Regulatory Framework	Town and Country Planning Act (1953)	Town and Country Planning Act (1977)	Resource Management Act (1991)
Number of Pages	68	168	702 (Chapters 1-15)
Central City	Commercial development only	Residential allowed, varying height restrictions	Residential allowed, varying height restrictions
Inner Residential	Up to 40% site coverage 12.2m height limit	Up to 40% site coverage 10m height limit 3m front setback 1.5m side setback 300m ² minimum lot size	Up to 40-50% site coverage 7.5-10m height limit 1m front setback 35 m ² outdoor space multi-units discretionary restricted
Outer Residential	Up to 40% site coverage 12.2m height limit 4.5m front setback 6m side setback multi-units conditional <i>'provided they are similar in character to that of detached housing'</i>	Up to 35% site coverage 8m height limit 3m front setback 3m side setback 400m ² minimum lot size 40 m ² outdoor space multi-units conditional	Up to 35% site coverage 8m height limit 3m front setback 50 m ² outdoor space multi-units discretionary restricted
Parking	1 off-street per dwelling	1 off-street per dwelling	1 off-street per dwelling (except CBD)

² See Appendix D for a map of suburbs in Wellington City.

which has been subject to almost continuous modification since it became operative in 2000. As of February 2016, there were 81 adopted or proposed plan changes. As a result, the District Plan is a patchwork of text hailing from many planning eras, with some sections dating back to the previous District Scheme and others less than one year old. In addition to meeting statutory requirements under the RMA, Wellington's District Plan also reflects local planning priorities and, along with other Wellington City planning policies, sets forth a vision for growth that is distinct from that of other New Zealand cities. The Urban Development Strategy (UDS) is a non-statutory guidance document that was introduced in 2006 and provides the long-term direction for managing growth in the City. Its key goals are: a compact city, to integrate transport and land use, to locate growth where benefits are greatest, and to ensure quality of place.

To achieve these goals, the UDS introduced the concept of the growth spine, which stretches from Johnsonville, through the central city to Kilbirnie. The growth spine is aligned with the city's main public and road transport corridor, and the UDS seeks to locate the majority of growth along this spine (Wellington City Council, 2006) (Figure 2.8). In order to assess the impact of the District Plan and the Urban Development Strategy on compact development and sustainable urban development, I will review the nature and impact of planning rules applying in different areas of the City.

Figure 2.8: Wellington Urban Development Strategy

Source: Wellington City Council (2006)

Residential area rules

The current Wellington City District Plan separates the city into four main residential zones: central, inner residential, outer residential, and Medium Density Residential Areas, with each having its own rules and standards for residential development (Figure 2.6) (Wellington City Council, 2011b, p. 4). Each of these areas is characterised by distinct planning rules, urban forms, architectural styles and land use types.

For inner and outer residential areas, the aim of the District Plan is to allow for limited amounts of residential development while ensuring that this development is consistent with the existing urban form and does not result in significant neighbourhood change, principally in the form of intensification (Wellington City Council, 2007b). The current planning regime for residential areas is largely a product of historical zoning restrictions and an infill housing review which was initiated in 2006 in response to a perceived public backlash against increasing amounts of infill development following the previous liberalisation of the District Plan, particularly against multi-unit developments within existing neighbourhoods (Wellington City Council, 2012a). This review resulted in the city adopting a two pronged approach, firstly limiting infill in existing neighbourhoods, and secondly encouraging infill and increased density around selected centres, entitled Medium Density Residential Areas (Wellington City Council, 2007b, 2009b).

District Plan Change 56, 'Managing Infill Housing Development', proposed in 2007 and adopted in 2009, revised the rules for the inner and outer residential areas in order to limit infill in these neighbourhoods. It was explicitly a response to "a significant public backlash, with many residents concerned with the impact that infill and multi-unit housing was having on the character and amenity of their suburbs" (Wellington City Council, 2009b, p. 5). In 2006, the city's Residential Satisfaction Survey investigated attitudes towards infill development and planning among a representative sample of city residents. 61% preferred the strategy at the time of allowing compact infill development throughout the city, while 25% preferred the proposed change to limit infill development and focus intensification within selected centres. With regard to the stringency of planning controls, 47% said they were satisfied with the current controls and 37% said they wanted more strict controls on development (Wellington City Council, 2007b). Despite this representative survey evidence that there was not majority support from city residents as a whole to tighten restrictions on infill development, the Council proposed a plan change to do so. The proposed plan change received 83 public submissions, six of which were from residents' associations. Support for the plan change came from 47 of the submissions, while only 13 were in opposition

to the plan change. All of the residents' associations voiced strong support for limiting infill, with one going as far as to say that no new dwellings of any kind should be allowed in their suburb (Wellington City Council, 2007c).

As a result of this plan change, the current District Plan largely views infill development and medium density housing as a blight which lowers residential amenity. In residential areas, infill development is controlled through five key mechanisms: separation of land uses, restrictions on density, restrictions on multi-unit developments, building height restrictions, and requirements for parking.

A central goal for residential areas is to limit density and to ensure that future development is of a scale compatible with the existing development pattern, standalone dwellings. The District Plan makes multiple references to the innate negative characteristics of multi-unit development, which are seen to be inherent to the housing type rather than due to other factors such as architectural style or building quality. These negative characteristics include impacts on 'neighbourhood character', decreased amounts of daylight, and decreased privacy for occupants as well as neighbouring properties (Wellington City Council, 2007b, 2007b, 2012b).

Single dwellings, even when built up to full site coverage and height, retain a significant degree of openness and greenery on site. However, infill housing and multi-unit developments designed and built in accordance with the bulk and location controls can have quite different effects on the amenity of surrounding properties. Over-development of a site can result in adverse amenity effects for adjoining neighbours, and may affect residential character of a street or neighbourhood... (Wellington City Council, 2007b, p. 18)

The Council's goal of generally limiting density is grounded in the belief that one to two storey standalone homes with setbacks and spacious backyards provide greater residential amenity to their inhabitants and neighbours than other forms of housing, and furthermore that higher density housing inherently reduces residential amenity, not only for their occupants but also for adjacent neighbours and the wider neighbourhood. These are, of course, value judgements.

Within the inner and outer residential areas, non-residential activities (with the exception of working from home and early childhood centres) are discretionary activities which require resource consent. This presents a considerable obstacle for the development of small scale retail and commercial activities which could be compatible with residential areas, making strict separation between residential and other land uses the *de facto* development pattern of choice (Wellington City Council, 2012b). As a result, within newer suburban areas, retail and commercial activities are primarily restricted to suburban centres and the creation of new suburban centres is limited. While

corner dairies and other small retail storefronts, such as coffee shops, are staples of inner residential areas such as Mt Victoria and Mt Cook, newer residential areas are almost completely devoid of these amenities. This bias against mixed land use has implications for access to local amenities within walking distance, one of the key tenets of smart growth and sustainable urban design, as many newer suburbs were developed without easy local access to suburban centres or small retail stores.

The central area

The central area consists of Te Aro and Wellington Central, along with the southern portions of Pipitea and Thorndon, and bordering streets in Mount Victoria and Mount Cook (Figure 2.6) (Wellington City Council, 2011b, p. 4). Within the central area, the majority of original brick and wooden Victorian buildings have been replaced by high and medium rise concrete and steel buildings. Today, the central area consists of a mixture of commercial and residential land uses, and also serves as the nation's seat of government. It is the primary location of jobs within the City, with 49% of jobs located in the central city areas of Te Aro, Thorndon, and Lambton (Statistics New Zealand, 2013). It is also the central node of the region's transport network; the SH1 motorway runs through the central city and 58 of the region's 98 bus routes stop in the central city (Metlink, 2015).

In the past three decades, the central area has experienced a transformation from a commercial (office and retail) area to a site of residential development that now accommodates the majority of the city's population growth. Whereas in 1990 the central city population had dropped to an estimated 7,000 people, by 2013 the population had tripled to an estimated 21,000 people, and this number is expected to exceed 30,000 by 2043 (id Consulting Limited, 2014; Statistics New Zealand, 2013) (Figure 2.3). However, the 2043 central city population is only expected to be approximately equal to the central city population at its peak in 1900 of around 37,000. Between 1996 and 2013, nearly 60% of the City's population growth occurred in the central area. This represents a considerable shift in the pattern of development, with inner city apartments now replacing suburban standalone dwellings as the principal form of development in the city (Hinton, 2013; Morrison & McMurray, 1999; Page, 1996).

In contrast to the residential areas, the central area has very few restrictions on the development of residential units. There are no specific standards relating to residential amenity, such as outdoor space or floor area requirements. There are no minimum parking requirements, nor are there limitations on mixed use developments; single buildings can include a mixture of commercial,

retail, and residential uses. The central area has varying levels of height restrictions which range from 10 meters to 50 meters, depending on location, providing significant capacity for additional residential development in the area (Wellington City Council, 2012c). Some limitations on building in the central city exist in the form of restrictions for the purposes of sunlight and view shaft preservation. The Urban Development Strategy assumes that an additional 12,000 residential units will be constructed by 2050, suggesting that there is a considerable amount of buildable space within the central area (Kos, 2006; Wellington City Council, 2006).

In the absence of prescriptive restrictions on development, the central area has emerged as the primary location of new development in Wellington, offering a range of units which appeal particularly to smaller households. In 2009, the most common household types in the Wellington central area were couples without children (39%) and single person households (32%). Less common household types were unrelated groups (15%) and parents with children (12%). As would be expected given smaller average household sizes in the Central City relative to the rest of the City, two bedroom apartments predominate, with roughly equal minorities of one bedroom and three bedroom apartments. In the absence of outdoor space and size requirements, central city apartments offer a range of sizes and outdoor space amenity. Apartment sizes in the central area range from less than 50 to over 100 square metres. In regard to open space, 57% of apartments have outdoor space in the form of private balconies, 18% have another form of private open space, and 25% have no open space provided (Wellington City Council, 2009a).

In the absence of minimum parking requirements and free kerbside parking, parking has been unbundled from residences in the central area. This allows developers the ability to cater to car free households and households willing to park remotely by providing them lower cost residential units which come without a parking space. A 2009 survey of inner city apartment dwellers found that 55% of households owned a car and parked it in their building, 12% of households owned a car and parked remotely, and 31% of households did not own a car, providing solid evidence that the absence of a parking requirement has allowed a significant number of apartments to be built without parking (Wellington City Council, 2009a). The percentage of households without a motor vehicle has been growing in the Wellington CBD, with 30% of households without a motor vehicle in 2001 and 43% of households without a motor vehicle in 2013, substantially higher than the citywide average of 15% of households. This is in contrast to New Zealand as a whole, where only 8% of households did not have a motor vehicle in 2013, and the percentage of households with a motor vehicle grew by 2% over the same time period (Statistics New Zealand, 2013).

The inner residential area

The inner residential area consists of older suburbs which surround the central area, and includes the suburbs of Aro Valley, Newtown, Berhampore, Mt Cook, Mt Victoria, as well as parts of Kelburn and Thorndon (Figure 2.6) (Wellington City Council, 2011b, p. 4). Unlike the central area, most dwellings are still the Victorian and Edwardian wooden detached dwellings built in the decades around 1900 (Page, 1996; Wellington City Council, 2011b). There is also a considerable number of infill single and multiple unit dwellings that have been built subsequently, particularly in Mt Cook and Newtown. Today the area has medium population densities, ranging from 30 to 90 persons per hectare (pp/ha), achieved through a mixture of small lot sizes, high levels of site coverage, and narrow lots. These neighbourhoods retain their original urban form, with streets that are oriented towards pedestrians and public transport users, although on street parking requirements for newer dwellings has resulted in an increasing orientation towards cars.

Under the current District Plan, building footprints are limited to 40-50% of a site in the inner residential area. Density is also limited through outdoor space requirements, height limits, sunlight requirements, and setback requirements. In the inner residential area, at least 35 square metres of outdoor space must be provided per unit and a 1 metre minimum setback is required. Setback requirements require dwellings to have a minimum front yard, while side yard setbacks restrict the construction of row house and townhouse style housing (Wellington City Council, 2012b). Height restrictions range from 7.5 metres to 10 metres depending on the suburb. This is in contrast to many existing dwellings in inner residential neighbourhoods which have no or minimal setbacks from the street and have high site coverage (Figure 2.9). Infill development is further restricted by heritage restrictions which prohibit the demolition or substantial alteration of a considerable number of buildings constructed before 1930. For the inner residential areas, the planning rules

Figure 2.9: Aro Valley Heritage Area

(a) Lots and building outlines

(b) View of Aro Street

Source: Author

equate to preserving the existing level of density by prohibiting intensification, and in some cases reducing density and moving from a pedestrian oriented to a car-oriented development pattern.

The outer residential area

The outer residential area consists of a variety of different neighbourhood types built over many decades. Some are older and share commonalities with inner residential neighbourhoods (such as Seatoun, Island Bay and Lyall Bay), while others were built between the 1940s and the present day and are more car oriented (Wellington City Council, 2011b). While architectural styles vary, these suburbs are characterised by lower density, large lot sizes, hilly topography, predominantly off-street parking, and large distances between residential and commercial land uses (Wellington City Council, 2011b). Between 1970 and 2001 the developed land area of the city expanded considerably, and 80% of the city's population growth was accommodated in the outer residential area (Figure 2.2, 2.3). Today, the outer residential area accommodates a large minority of new development, and remains the key site of greenfield growth. From 2008 to 2012, the outer residential area was home to 45% of new residential units, with these split equally between greenfield and infill sites (Wellington City Council, 2013a).

In the outer suburban area, outdoor space of at least 50 square metres is required per unit and building footprints are limited to 35% of a site. In addition, a 3 metre setback is required, building heights are limited to 8 metres, and one parking space is required per residential unit. Infill dwellings are even further restricted, and have a maximum height of 4.5 to 6 metres (effectively two storeys). For the outer residential areas, the current planning rules preserve low density, car - oriented development, allowing for limited numbers of new dwellings only if they are consistent with this urban form.

Medium density residential areas

The second part of the Plan's approach to infill and medium density development is its recent creation of Medium Density Residential Areas (MDRAs). These were conceived as a means of providing for focused areas of medium density development after non-targeted infill was severely restricted in existing residential areas from 2009 onwards. MDRAs were proposed as a means of achieving sustainable urban growth and transit oriented development by directing intensification to transit accessible centres with local amenities (Wellington City Council, 2012a). District Plan Change 72, 'Residential Review', was notified in 2008 and included the creation of two MDRAs, one in Johnsonville and one in Kilbirnie. These two areas are retail and shopping centres located

in the outer residential area, and are primarily surrounded by single storey standalone homes. The intent of this plan change was to encourage intensification through the development of multi-unit and higher density development in these suburban centres and the immediate surrounding area (Wellington City Council, 2009b). Two additional MDRAs, in Tawa and Karori, were proposed in 2015. Like Johnsonville and Kilbirnie, they are proposed around the town centres of neighbourhoods in the outer suburbs that are currently surrounded by low density residential development.

While the original intent of the MDRAs was to achieve targeted intensification, the rules currently set forth for residential development in the MDRAs will result in relatively low residential densities, estimated to be comparable to the inner residential area for the Kilbirnie MDRA and lower than in the inner residential area for the Johnsonville MDRA (Wellington City Council, 2012a). Allowed densities for the two MDRAs are estimated to be between 25 and 35 dwellings per hectare. While medium density housing can be defined in various ways, this is at the lower end of what is generally considered to be medium density. The Housing New Zealand Corporation defines medium density housing as housing between 35 and 125 residential units per hectare, while the minimum density required to support high quality public transport, such as light rail, is estimated to be at a minimum 74 jobs and residents per hectare (Guerra & Cervero, 2011; Housing New Zealand Corporation, 2005). The estimated 30 dwellings per hectare equates, given the average household size in Wellington of 2.6 persons per household, to around 78 residents per hectare (Statistics New Zealand, 2013).

These allowed densities are a result of site coverage requirements, parking requirements, and building height restrictions. Both MDRAs have the same maximum 50% site coverage requirement as the inner residential area. Unlike the other residential areas, they do not have outdoor space requirements. However, the site coverage requirement effectively achieves a comparable effect: at least 50% of the site cannot be built on and must be used as open space. The advantage this offers, as compared to enforcing density restrictions through outdoor space requirements, is that more of this space can be used for parking rather than as green space. Nevertheless, both the Johnsonville and Kilbirnie MDRAs are subject to minimum parking requirements, including the requirement for additional parking spaces for multi-unit developments, despite being centred on transit hubs (Wellington City Council, 2012a; Wellington City Council, 2009b). Given that there are no requirements regarding the appearance of or location of this parking and that no outdoor space is required, it is entirely possible that new multi-unit residential units could be built where all of a site's open space is dedicated to vehicle parking and manoeuvring. For many multi-unit

developments, it may be necessary to devote the majority of open space to parking, as under the District Plan rules they must provide one parking space per unit as well as additional guest parking.

The Johnsonville MDRA has an 8 metre maximum building height, which effectively limits dwellings to two storeys. The Kilbirnie MDRA has a 10 metre maximum building height, which allows dwellings of up to 3 storeys and is the same as the limitation in the inner residential area. For both MDRA's, a 3 metre front yard setback is required, whereas for the inner residential area a 1 metre front yard is required. The Tawa and Karori MDRA's are also proposed to allow site coverage of up to 50% and heights up to 10 metres, and maintain the minimum parking requirement. While the inner residential areas are oriented towards pedestrians and public transport users, the planning rules in the two MDRA's do not require such an orientation and could result in a car-oriented development pattern.

Parking requirements

In addition to residential building requirements, parking requirements substantially impact Wellington's urban form. Parking requirements in the inner residential area have shifted new residential development from a walking and public transport oriented pattern towards a car-oriented one. New dwellings must provide one parking space per dwelling unit. Most obviously, the requirement places a further limit on development density above and beyond the previously discussed limits. A parking space must be a minimum area of 12.5 square metres, although the space required can be much higher depending on the vehicle manoeuvring requirements of the site (Wellington City Council, 2011a).

Dwellings in inner residential areas were originally built without off-street parking and were oriented towards pedestrians; homes were oriented towards the street, with either small fenced front yards or buildings built up to the property line. For infill dwellings, many front yards have been replaced with parking spaces and vehicle manoeuvring areas, eroding the streetscape character and requiring kerb cuts that reduce the quality of sidewalks for pedestrians. Kerb cuts also require the removal of on-street parking area, transferring public road space from collective to individual use. As driveways have an allowable width of 3.7 metres and legal requirements restrict parking within one metre of a driveway, the creation of one off street parking space removes as much (kerbside) parking as it creates (Wellington City Council, 2011a). The parking space requirement is especially pronounced for multi-unit dwellings, which must provide a space for each residential unit as well as an additional guest parking space for every 4 units (Figure 2.10) (Wellington City Council, 2011a).

Another effect of parking requirements is that they reduce the development potential of sites that are not adjacent to a roadway. Due to the hilly nature of Wellington, many original dwellings in the inner residential area are not adjacent to a roadway, and are instead connected by a path or stairway. To build on such a location under the current District Plan, an application to the Council is needed to encroach on the publicly owned roadway for the purposes of building a parking space adjacent to the street (Wellington City Council, 2011a). This not only greatly adds to the transaction costs of building on such sites, but also amounts to a transfer of land from public to private ownership for the purposes of parking private vehicles. It also limits the ability to subdivide properties for development when a new site would not be adjacent to a roadway, placing a further limit on development in existing neighbourhoods.

The minimum parking requirement in Wellington was adopted in 1966 following the guidelines produced by the US Institute of Traffic Engineers. This coincided with the near universal adoption of minimum parking requirements in US cities; between 1940 and 1969 almost all American cities adopted minimum parking requirements as a means of dealing with problems associated with rising automobile ownership rates (Ferguson, 2004). The Institute of Traffic Engineers guidelines have subsequently been criticized for both lacking an empirical basis and for providing for peak rather than average demand (Shoup, 2005). This minimum parking requirement for dwellings outside the

Figure 2.10: Housing before and after parking requirements

Source: Author

central city has remained unchanged since its adoption in 1966. The District Plan offers two brief justifications for its parking requirements. In Chapter 4, the Plan states that “Traffic on roads, whether active or stationary, can have major impacts on the amenities of Residential Areas. Council will continue to use traffic management techniques to control congestion and parking” (Wellington City Council, 2011b, p. 4/10). In Chapter 5, the Plan states that, “the parking and access conditions are aimed at maintaining access and safety on suburban streets but parking is not required for every person on a site who may own a vehicle” (Wellington City Council, 2012b, p.7). Since access, safety, and amenity do not necessitate off-street parking, it is not obvious that the City’s stated goals are consistent with the parking requirements in the Plan.

This level of market intervention is essentially an anomaly in a District Plan that is in principle permissive with regard to dwelling amenities. Homes are not required to provide other similar amenities, such as proximity to public transport, or interior amenities, such as floor space or heating. In the absence of parking requirements, developers would be free to provide the amount of parking that they perceive the market demands, as is the case for other household amenities. In many cases, this might not result in much of a change from the status quo, as developers might often continue to provide one or two parking spaces per dwelling. However, it would also allow developers the ability to cater to car-free households as well as those willing to park remotely.

Density Requirements

For the inner residential area, rigid District Plan requirements regarding site coverage, lot size, and height are a significant deviation from the original development pattern. The original housing stock in the inner residential area is characterised by a variety of lot sizes and housing morphologies, most of which would not conform to the extant District Plan. Many, if not most, houses are built on very small or narrow lots, are not adjacent to a roadway, do not have front setbacks, exceed two storeys, do not have ‘adequate’ outdoor space, or are very close to neighbouring homes. Nearly all of these historical homes were originally built without off-street parking. For example, Aro Street, which is recognized by the District Plan as a heritage area and consists primarily of buildings built between 1890 and 1930, features a variety of one and two storey building types. This includes duplexes, houses with and without front setbacks, dwellings on narrow sections, sections with and without substantial outdoor space, and houses built very close (less than one metre) together. Lot sizes range in size from 150 to 300 square metres, front yard setbacks range from 0 to 1.5 metres, side yard setbacks range from 0 to 1.5 metres, site coverage varies from 40 percent to 80 percent, and nearly all dwellings do not provide a parking spot. All of these features do not conform to the

uniformity and low density required under the extant District Plan. In essence, many of the key elements of Aro Street which give it historical character and diversity are now prohibited under the operative District Plan (Figure 2.9).

The rural area and urban fringe

Rural land in Wellington City constitutes about 52% of the total city land area, but has a small population of roughly 1,200 people. The District Plan establishes a containment policy of restricting new development to within the outer green belt and places heavy restrictions on subdivision in the rural area. These restrictions are designed to restrain the perceived continuing demand for residential development and lifestyle blocks within the rural area. The majority of undeveloped land that is zoned for greenfield development is located north of the city between Johnsonville and Tawa; greenfield subdivision is managed by the city's Northern Growth Management Framework (Wellington City Council, 2011c).

The Northern Growth Management Framework is implemented through two plan changes, one which amends guidance for residential subdivision (DPC 46) and the other which introduces a structure plan for the development of greenfield land between Johnsonville and Tawa (DPC 45). These principal undeveloped tracts in Wellington open for residential development are located about 14 kilometres from the CBD and will be connected to the city's transport network through a planned motorway, known as the Petone-Grenada Link Road. Although these District Plan changes were proposed in 2006, they were not adopted until 2013 due to appeals. The structure plan seeks to provide 'sustainable urban growth' and to incorporate elements of new urbanist principles into the development of this greenfield land. Goals for the structure plan include: promoting interconnected streets, residential lots oriented to the street, locating housing near employment, neighbourhood centres and public transport, mixed use development and connection to existing neighbourhoods.

The area is split into two residential development areas. Residential Area 1 one is intended for low density standalone housing development. It is subject to the same height, setback, outdoor space requirements and site coverage requirements as in the outer residential area. However, unlike other low density areas in the city, a range of lot and dwelling sizes is intended. Residential Area 2 is intended for medium density housing within walking distance of the neighbourhood centre and employment area proposed as part of the development. Multi-unit housing is encouraged and a minimum density of 25 household units per hectare is required. Additionally, the maximum site coverage is 50% and the maximum height is 9 metres. Residential development is also allowed on

upper floors of buildings in the planned town centre, a use which has been either discouraged or prohibited in other town centres in the City in the District Plan.

The town centre will be required to have an active street front, with parking provided on-street or in the rear of buildings. The structure plan also introduces a new approach to road design requirements. While previous standards for new roads required parking on both sides of new streets and two carriageway lanes, the structure plan has a more flexible approach. The structure plan sets out an objective of 'safe and pleasant for vehicles, pedestrians and cyclists' and allows for street designs that are responsive to the surroundings and are narrower in steep areas (WCC, 2013, p. 45). In addition to meeting District Plan requirements, consent for development in the area will be given based on completion of a detailed plan which demonstrates fulfilment of the desired outcomes of the structure plan.

Taken together, the many requirements set forth in the proposed district plan changes will enforce a strict pattern of residential development, with a narrow window of density and urban form permitted within each zone.

2.8 Impact on Development Patterns and Sustainability

Wellington City Council produces a projection of growth in dwellings at the suburb level over the next 30 years (2013-2043). This growth scenario is intended to reflect the allowed amount and type of development under the current planning regime, demographic trends, and economic forces, including demand for housing types and locations. The amount of growth in each suburb is based on both the number of developable sites in a suburb and the projected allowed amount of infill under the current District Plan. However, these anticipated levels of growth may not be achieved if there is not sufficient demand for development in an area or if the planning rules limit development that would otherwise be demanded. For example, 12 dwellings per year were projected to be built in the suburb of Kilbirnie in 2014, 2015, and 2016, largely due to the creation of the MDRA which is intended to encourage infill development. Furthermore, the number of developments in that suburb is expected to steadily increase each year, with the area growing by 33% by 2043. However, no new dwellings or subdivisions were consented in Kilbirnie from June 2015 to March 2016 (id Consulting Limited, 2014; Wellington City Council, 2016). A similar, although less dramatic, pattern of slower than expected growth has been seen across the City, with 16% less than expected resource consents issued from July 2014 to June 2015 (Wellington City Council, 2015).

To what extent are the Wellington District Plan and other planning documents drivers of development patterns rather than responses to market forces? The answer to this question depends largely on what type and scale of development would have occurred in the absence of planning restrictions. Would developers choose to build different types and quantity of new developments and does the consumer have an unmet demand for them? Evidence suggests that the District Plan shapes urban form by limiting where and how development can occur and imposes a development pattern which limits access to amenities and distorts the realisation of housing preferences through parking requirements and building restrictions.

Whereas smart growth principles advocate for a mixture of land uses and the promotion of destination accessibility for residents, one of the principal goals of the District Plan, and most zoning documents worldwide, is to geographically separate land use types. The District Plan seeks to separate residential from commercial, retail, and recreational land uses as they are thought to diminish amenity for residents. However, the District Plan also reveals the inherent tensions between conflicting city goals, and acknowledges that “allowing more mixed activity in Residential Areas also helps to promote Council’s aim of achieving a more sustainable city” (Wellington City Council, 2012b, p. 68).

Parking

Wellington’s car ownership rates and kerbside parking occupancy rates suggest that the current minimum parking requirement results in an oversupply of parking, especially in the inner suburbs. These suburbs have relatively low rates of car ownership; in no inner suburban neighbourhood do more than 80% of households have a motor vehicle. Thorndon, Mt. Victoria, Newtown, and Aro Valley have vehicle ownership rates nearly as low as in the central area, where residential parking is not required and long-term kerbside parking is virtually non-existent (Figure 2.11). Automobile ownership rates are also relatively low in several outer suburbs. For example, in Kilbirnie East 29% of households do not have a motor vehicle (Statistics New Zealand, 2013). From 2006 to 2013, the proportion of households without a motor vehicle rose from 14.1% to 15.1% even as incomes increased, reversing a long trend of increasing automobile ownership with rising incomes (Statistics New Zealand, 2013). Despite low automobile ownership rates and the fact that many older homes do not feature parking, new dwellings in these areas must provide one parking spot per dwelling unit, with additional spots required for multi-unit dwellings.

Figure 2.11: Households without a motor vehicle

Source: Author, using data from NZ Census 2013

At the same time, kerbside parking supply in many suburbs is high while occupancy rates are low, suggesting that the provision of additional off-street spots may not be warranted from a demand point of view. A Wellington City Council funded survey of parking in seven Wellington neighbourhoods found that the availability of kerbside parking spaces per dwelling met or exceeded household vehicle ownership rates in every suburb except Mt. Victoria (Selby, 2007). This is without considering off-street parking provision as part of the parking supply, suggesting that kerbside parking alone would be sufficient to fulfil parking demand in every neighbourhood surveyed in the study. This may explain relatively low kerbside occupancy rates, which were 69 percent in Mt Cook and 74 percent in Newtown, the suburbs that had the next highest occupancy rates after Mt Victoria (Selby, 2007). This is in contrast to international standards which recommend 85 per cent occupancy for optimal efficiency (Shoup, 2005). These numbers suggest that additional parking demand accompanying residential growth could be accommodated through the existing kerbside parking supply or parking provided by the developer to meet anticipated need, rather than through requirements for the construction of off-street parking. Moreover, if policy is to 'lean against' car-related carbon emissions, and encourage use of alternative modes, there is no strong case for continuing to require off street parking.

Vehicle ownership rates relative to provision of kerbside parking in Wellington suggest that parking requirements in the District Plan distort the housing market by requiring an amount of parking that is surplus to demand. This in effect forces households to pay for parking they do not want or need, decreasing housing affordability for such households. It also decreases the potential number of units that can be developed on a piece of land, which acts as another means of decreasing the affordability of individuals units and also limits the overall supply of housing in the City.

Limits on residential development

Wellington's recent experience with plan changes suggests that the residential housing market in the City is significantly moulded by planning restrictions and deliberately so. The Plan explicitly aims to combat the current demand for rural subdivisions, greenfield growth, and residential infill by placing strict controls on these activities, and acknowledges that more of these types of development would occur in the absence of current planning restrictions. These constraints likely direct development to other areas where development is less restricted, such as the central city, northern suburbs and adjacent cities.

While the controls on rural subdivision clearly limit the development of lifestyle blocks and residential subdivision in the rural area, they have a less clear effect on suburban residential growth on greenfield sites. From 2007 to 2011, less greenfield development occurred than was projected in the Urban Development Strategy (22% of new units were greenfield against 34% expected). This is in spite of the relatively large amount of greenfield land zoned for residential development, which the Council estimates is sufficient for all projected greenfield development until 2030. This would suggest that the current availability of greenfield sites exceeds demand for these units and that the 'market' is moving away from greenfield development. Another explanation for relatively low greenfield growth is land banking and the controlled release of greenfield land by developers in order to maximise profits. A Productivity Commission report found that two developers own the majority of developable greenfield land in Wellington City, and only release 100 to 150 units per year in order to maximise sale prices (Productivity Commission 2015). In contrast to the weaker than expected development on greenfield land, there has been a greater than anticipated demand for high and medium density development. From 2007 to 2011, more high density (41% compared to 36% projected) and medium density (37% compared to 30%) housing has been constructed as compared to the Urban Development Strategy estimate (Hinton, 2013).

A Productivity Commission inquiry (2015) argued that urban planning in New Zealand under the RMA is subject to regulatory capture, especially by homeowners attempting to protect the amenity in existing neighbourhoods. For example, a disproportionate number of submissions by higher income home owners led Auckland Council to reduce the allowed densities under their proposed district plan, creating a misalignment between areas of high demand and where growth is allowed for. Similarly, Fischel (2004) argues that the primary impetus behind the rise and continued use of zoning in the US is the desire of owners of single family dwellings to preserve their property values, as for most people a residence is their single largest investment. He argues that zoning protects standalone house values by eliminating the potential negative impact of multi-unit dwellings and commercial/industrial uses on home values and by reducing the overall supply of housing in an area. This is consistent with one of the objectives for the introduction of planning in Wellington, maintaining the stability of individual property values. Wellington's recent experience with limiting infill – including a process in which consultation, primarily with homeowners and residents' associations, outweighed representative survey results - seems to suggest that the interests of existing residents in neighbourhoods, especially homeowners, were disproportionately considered and catered to when the current strategy of targeted infill was adopted. The interests of homeowners appear to have been much more strongly reflected in zoning rules since the legislative

context for planning has mandated public consultation and allowed for appeals of planning decisions to the Environment Court.

2.9 Conclusion

Wellington City has largely followed a concentric ‘tree ring’ pattern of residential development, expanding from the central city towards the urban fringe, with the oldest houses nearest to the centre and ‘younger’ housing towards the urban fringe. Since the 1990s, this pattern has been altered by the steady growth of new housing in the central city and inner suburban areas. For the first 100 years of the city’s growth, Wellington developed without planning restrictions. The city’s development pattern was a result of supply and demand as well as the transport infrastructure provided. These forces resulted in a relatively compact city that was oriented towards public and active transport. Since 1945 the city has experienced a rise in car dependence, outward expansion, decreasing density, and separation of land uses. While these trends can be seen as resulting from demand, the spatial form of development is also undoubtedly due to planning interventions and transport planning decisions. These include the central government’s decision to prioritise funding of motorways over public and active transport improvements, the building, largely on greenfield sites, of social housing in the form of standalone dwellings for families, and successive planning regimes that have privileged some types of development while prohibiting others. During the three decades that residential development was prohibited in the central city, its population dropped by two thirds, a pattern that quickly reversed once the prohibition was lifted. Similarly, in the 1960s and 1970s the majority of residential development was in the form of multi-unit dwellings, and multi-unit development in the suburbs all but disappeared once a new planning regime essentially prohibited this type of development.

Within popular culture, Wellington is frequently cited as a liveable, compact city, and this compactness is generally perceived to be due to its hilly topography (Ropata, 2013). However, Wellington’s urban form is as much a product of present and past transportation and land use planning and public investment choices as it is of geographical circumstance and market preferences. The city’s residential development patterns are not simply a reflection of market supply and demand, but also the transport infrastructure provided and the strict boundaries within which the housing market is allowed to operate. These planning restrictions and transport investment decisions have impacts on environmental, health, and social outcomes. This is not to say that planning restrictions which alter the supply of housing and land are necessarily undesirable, as there are reasonable arguments for shaping the pattern of development to meet environmental, social and economic goals via district plans. For example, in the absence of a cost-reflective price

on carbon emissions, people ‘over-produce’ carbon emissions, and there may be a case for transport-related policies that constrain vehicle emissions. The critical question is not whether or not the pattern of residential development is shaped, but whether or not it is shaped in a way that is consistent with the city’s environmental, economic and social goals. There will be many cases where a market intervention is justified, as the greater public good outweighs the loss of choice in housing or land use. However, the current rules on infill development appear to be oriented to the interests of existing homeowners rather than the wider community and to car users rather than users of other modes.

While some planning restrictions further the Council’s stated goals, others seem to work directly against the Council’s long term goals and policies. Parking requirements which encourage a car oriented development pattern run counter to the Council’s long-term goals of increasing public and active transport use, decreasing car use, and maintaining a compact urban form. The current treatment in the District Plan of medium density development and residential infill as inherently undesirable and detrimental is in direct conflict with the City’s stated goal of a compact city. Severe restrictions on residential development likely increase housing prices and limit or displace future population growth, working against efforts at providing affordable housing and achieving sustainable economic development. If these restrictions also result in development shifting to other territorial authorities, then they may also support sprawling development patterns and carbon emissions from commuting.

The current planning restrictions on residential development make it impossible to determine what true consumer housing and travel preferences are through a revealed preference study, as unconstrained choices cannot be revealed in the current marketplace. While it is commonly assumed that the current development pattern of residential development is the result of consumer preferences, this assumption is fundamentally incorrect in Wellington City. Rather, the current marketplace merely shows the decisions that people make within the strict bounds of current planning restrictions, and the legacy of historic restrictions. It appears likely that there is a considerable unmet demand for infill development close to amenities in existing neighbourhoods, as well as low density development on rural land. Determining the extent to which the current housing supply is mismatched with demand requires the use of other research methods, such as a stated choice study. Greater knowledge regarding consumer preferences can inform whether or not an intervention in the current market would be justified, not only for environmental and other planning reasons, but to better enable consumer demand to be met.

CHAPTER 3

LITERATURE REVIEW

3.1 Introduction

Given that urban areas are the primary location of population growth and where the majority of global population lives, it is unsurprising that the research on the consequences of urban growth and form for both humans and the environment is vast and has been tackled within a range of fields across the social and physical sciences, including economics, ecology, urban planning, environmental studies, and public health. One area of research focus has been on the causes and relative costs and benefits of compact as opposed to sprawling or dispersed urban development patterns.

Development patterns are discussed in different terms by different researchers. *Sprawl* has been alternately described as leapfrog development, low density development, unplanned development, automobile oriented development, separation of residential and non-residential land uses, and excessive outward expansion (Brueckner, 2000; Ewing, 1994). Several approaches to planned development to combat sprawl have been proposed, with varying emphases and motivations. *Smart growth* has been described as a suite of goals for urban planning, including limiting the outward expansion of cities, raising residential densities, providing mixed land uses, and providing walking and transit oriented communities. *New urbanism* is an approach to planning that encourages high density, mixed use neighbourhoods, public transport accessibility, bicycle and pedestrian oriented street networks, public open spaces, and architecture designed to foster social interaction (Song & Knaap, 2003). *Traditional neighbourhood design* refers to characteristics typical of pre-World War II neighbourhoods - moderate density, an interconnected grid-like street pattern, a mix of land uses, town centres, and an orientation to walking and transit rather than cars (Lovejoy, Handy, & Mokhtarian, 2010). *Infill development* refers to development in existing areas rather than on undeveloped land (Steinacker, 2003). *Compact development* has been characterized by five variables referred to as the 'D' variables, coined by Cervero & Kockelman (1997) and Ewing & Cervero (2001). *Density* refers to the density of jobs and or population/households over a given area. *Diversity* refers to the mix of land uses and balance of jobs and housing in an area. *Design* refers to the interconnectedness and design of streets for either automobiles or a range of users. *Destination accessibility* refers to the number of jobs or destinations within a short distance. *Distance to transit* refers to the distance to the nearest transit stop. *Transit oriented design* refers to design intended to encourage public transport ridership through higher density development, walkability, and development clustered around transit nodes (Cervero, 2004).

Housing and neighbourhood density can be defined in a number of ways, and the conception of density can have important implications for the results that are found in studies (Mees, 2009).

Definitions of density can be related to the physical form of dwellings, the number of dwellings per unit of area, or the number of residents per unit of area (Table 3.1). The definition of density used will be dependent on both the context and the data that is available for use. Definitions based on aspects of dwelling typology and physical dwelling form may not be an accurate measure of the number of people or dwelling units in an area, as the number of dwellings or residents in an area may vary based on other factors, such as average household size, lot size, and occupancy rates (See Figure 6.17 to see the relationship between dwelling type and weighted population density in Wellington City). Definitions of density based on the number of residents or dwelling units per unit of area offer a more standardised approach to the measurement of density but are also subject to inconsistencies based on the measurement approach used. Dwelling density may not provide an accurate comparison of the relative population density of neighbourhoods, as household size is not uniform across neighbourhoods (Morrison, 2011). While measures of gross density may be skewed by non-residential uses (e.g., commercial buildings, parks), measures of net density require detailed data on land uses, may be difficult to calculate for areas with mixed use buildings, and the exclusion of non-residential land uses is subject to the judgement of the researchers. Population weighted density provides a measure of the residential density experienced by the average resident of an area (Glaeser & Kahn, 2004). As areas with fewer residents are given less weight, it is not skewed by non-residential uses and is subject to less measurement error than net density. However, it requires data on the population and land area at one finer level than the primary unit of analysis. In the present study, density refers to population rather than dwelling density and population weighted density is used whenever possible.

This literature review takes an interdisciplinary approach to the topic of urban growth patterns and focuses on the following aspects of urban form and the environment:

- drivers of urban growth patterns,
- environmental impacts of urban growth patterns,
- benefits of compact development,
- preferences for compact development,
- the proposed solutions to sprawl/impacts of zoning on urban growth patterns, and
- New Zealand research.

Figure 3.1: Residential density concepts and definitions

Type of measure	Metric (definition)	Notes
Dwelling typology	Composition of dwelling types (e.g. townhouse, apartment, standalone) in an area	Indicative, rather an accurate measure of the number or units or people in an area.
Physical dwelling form and density	Physical form of dwellings (e.g. floor area ratio, height, setbacks, or building envelope)	Measures of intensity and form of land use that is perceived by people. May not be an accurate measure of the number or units or people in an area.
Gross residential density	Number of residents or dwelling units divided by the total neighbourhood area	May be skewed by non-residential uses (e.g., commercial buildings, parks).
Net dwelling density	Number of dwelling units divided by total land area devoted to residential use	May not be an accurate reflection of population density due to differences in household sizes between neighbourhoods (e.g. areas dominated by one person households).
Net population density	Number of residents divided by total land area devoted to residential use	Requires detailed data on land uses and may be difficult for mixed use areas.
Population weighted density	A weighted average of the number of residents or dwellings divided by total land area	Gives a measure of density for the average person living in an area. Requires data on the population and land area at one finer level than the primary unit of analysis.

Source: Adapted from Boyko & Cooper (2011), Alexander (1993), Glaeser & Kahn (2004)

3.2 The drivers of urban growth patterns

The dynamics of urban housing markets and the geographic development of urban areas have been the subject of substantial academic inquiry dating back to the 1930s. Hypothesized determinants of the extent to which a city tends towards compact or dispersed development include: limits on the supply of land, transportation and communication technologies, consumer preferences for transport, housing and neighbourhood types, and zoning policies that dictate development patterns.

The most basic conception of a city is the reduced distance between people and firms that encourages commerce and employment by reducing transport costs. As such, transportation technology and infrastructure dictate the urban form of the city (Glaeser & Kahn, 2003). This relationship can be clearly seen in the historical growth patterns of cities and how they have changed with advances in transport technology and infrastructure. For the majority of the history of cities, urban areas were very compact with a variety of land uses in the same area; this is because most people needed to walk to work as well as to most other destinations. In the latter part of the nineteenth century, the development of the train and tram allowed cities to expand outward. This outward expansion was governed by transit lines, resulting in cities with a spider-web like shape. Walking was still necessary to get to and from transit stations, with the result that high density and a mix of land uses was the norm, with development clustered around transit stops. Urban areas built after the rise of the automobile, in contrast, are characterised by separation of land uses, low density, and extensive road networks to connect destinations. Cars drastically reduced transport time and costs, allowing for greater separation of land uses and low density than was possible under previous transport paradigms (Newman, 1992). Under this view, cars can be seen as the primary enabler, and perhaps root cause, of sprawl, as they reduce transport costs to the extent that walkable or transit oriented cities are no longer needed for commerce and employment to be possible (Glaeser & Kahn, 2003).

Another theory on the causes of urban form focuses on the concept of filtering, which posits that as new houses enter the market, older houses decrease in value due to ageing (Lowry, 1960). The theory posits that wealthier residents tend to relocate to new dwellings, leaving older dwellings available for the less affluent. This filtering is a means of providing affordable housing without the need for state intervention; in this respect filtering is not merely a policy neutral theory but advocates a free market rather than state supplied solution for housing for the poor. Filtering also dictates the spatial form of the city: older dwellings are located near the urban core with newer homes being located successively further away, thus expanding the urban area outwards in a

pattern of concentric circles, with the more affluent tending to locate further from the city centre. Filtering has been the subject of substantial debate and its ability to explain housing markets at a local level is variable (Gray & Boddy, 1979; Rothenberg, 1991). Under this framework, outward expansion is the natural result of durable housing stock and attempts to maximise utility from housing.

The monocentric city model, developed by Alonso, Mills, and Muth (Alonso, 1964) has been widely used by economists to explain patterns of urban development and despite its age is still used in Australia and New Zealand to explain patterns of land use and urban development (for examples see Kulish, Richards, & Gillitzer, 2012; Lees, 2014). In the model, the city is represented as a circular residential area surrounding a central business district where all employment is located. Each household derives utility from housing as well as all non-housing spending, both of which are paid from their income. The utility of housing is determined by its distance to the CBD (which is synonymous with commuting costs), lot size, and price. Rent must be lower at more distant locations proportional to the increase in transport costs. The model is an extreme simplification of reality; the city is static in time, all households are assumed to have the same preferences and income, and all households derive the same utility from housing (despite differences in residential location) in equilibrium. Land use is Pareto optimal at equilibrium, because there are no externalities and all land use decisions are made by the market (Anas, Arnott, & Small, 1998).

While it is an extreme simplification of the complexities in urban housing markets, the monocentric city model accurately explains many aspects of urban housing markets. The model predicts that housing density declines with distance from the city centre, while the price per unit of land decreases. In this sense, decreasing densities and increased lot sizes on the urban fringe are seen as a natural product of supply and demand. High land values close to the city centre dictate higher density, while low land values far from the city centre encourage larger homes. Outward urban expansion occurs due to utility maximisation, and the degree of urban expansion is dependent on transport costs, which include both direct transport costs and the value of time. The model is useful in that it presents an idealised version of an urban housing market which can be compared to actual housing markets; this comparison can provide insight into market failures and other forces.

Under the monocentric city model, housing location choice is the result of the combined utility obtained from housing and transport accessibility (particularly with regard to commute time); the extent to which property values rise in relation to distance to the central city can be viewed as a metric of the value consumers place on transport accessibility and low commute times relative to

housing. A relatively low premium on centrally located housing in the US between the 1950s and 1990s can be seen as evidence of a preference for larger houses over lower transport costs (Mieszkowski & Mills, 1993). Using data from the 27 largest US cities, Edlund, Machado, & Sviathci (2015) argued that while previous to 2000 higher income households tended to locate in suburban neighbourhoods distant from the central city, post 2000 data shows an increasing tendency to locate in the central city. The authors argue that this is due to the increasing valuation of time, especially among higher income households.

Brueckner (2000) argues that the outward growth of cities occurs due to three factors: a growing population, rising incomes, and falling commuting costs, and states that as such it should not be viewed as an inherently negative or socially undesirable phenomenon. Rather, Brueckner argues that excessive outward expansion occurs when market failures fail to internalise the external costs of outward expansion. The three failures identified are: the failure to account for the benefits of open space, the social costs of driving, and failure to make new developments pay for the infrastructure costs of their development. Under this conception of the cause of sprawl or 'excessive outward expansion', correcting these market failures by internalising externalised costs will curtail sprawl and lead to a reduction in the spatial size of the city. Anas & Rhee (2006), similarly to Brueckner, advocate for price mechanisms in the form of congestion tolls as a tool to internalise congestion costs, rather than urban growth boundaries. They argue that in addition to limiting the size of city, urban growth boundaries can have the unintended consequence of raising land values significantly. Burchell (2005) also argues that sprawling development is partly the result of a failure to internalise the infrastructure costs of development, and calls for the use of development contributions or impact fees as a means of forcing developments to pay their own infrastructure costs.

3.3 Urban form and travel behaviour

One of the most studied relationships in urban planning is that between urban form and travel behaviour, as well as resulting GHG emissions. Over 200 empirical studies have shown that the built environment influences mode choice as well as distance travelled (Ewing & Cervero, 2010; Leck, 2006). These studies demonstrate that compact urban areas are associated with decreased vehicle kilometres travelled (VKT) and increases in walking, cycling and public transport use. For example, McIntosh, Trubka, Kenworthy, & Newman, (2014) used structural equation modelling to investigate the relationship between urban form, level of public transit service, road length per capita, and centralisation on VKT per capita in 26 global cities over 40 years. Urban density,

followed by level of public transit service, were found to have the strongest impact on changes in VKT over time. Ewing & Cervero (2010) conducted a meta-analysis of more than 60 studies to measure the effect size of each D variable (density, destination accessibility, distance to transit, land use diversity, and transit oriented design) on transport behaviour. While all of the D variables had an influence on travel behaviour, destination accessibility had the largest influence. Ewing, Bartholomew, Winkleman, Walters, & Chen (2007) estimated that considering the impact of each D variable on travel patterns, a future focused on compact development could reduce VKT and resulting GHG emissions by 12 to 18% in 2050, as compared to a sprawling development pattern. The Fifth IPCC Assessment Report (2014) determined that transit oriented development and compact urban form significantly reduce carbon emissions from transport, and estimated that urban form related measures could result in greenhouse gas emission reductions of up to 30% in the medium to long term.

While it is widely agreed that urban form is correlated with travel behaviour – those living in denser neighbourhoods drive less than their counterparts in less dense neighbourhoods – there is some debate on the causality of this relationship and its relative importance as compared to transport policy measures.

A strand of urban form research has attempted to quantify the extent to which preferences or urban form determine travel behaviour. If urban form is the primary driver of travel behaviour, then a transition to compact urban form will result in less driving and increased walking and cycling for transport. Alternatively, preferences for travel and neighbourhood types could be the primary driver of residential location choice and resulting travel behaviour. In this case, the transport benefits of a transition to compact urban form may be overstated. This is referred to as the self-selection problem in academic research (Mokhtarian & Cao, 2008b). At least 38 studies have attempted to control for residential self-selection when determining the impact of urban form on travel behaviour. Almost all of them have found clear evidence of an influence of urban form independent of self-selection influences. However, nearly all of these studies also found that self-selection also influences travel behaviour; those who have a preference for compact development and alternatives to car travel are much more likely to use alternatives when they are in an environment that encourages alternatives (Ewing & Cervero, 2010). This strand of research also highlights the importance of understanding preferences when planning for sustainable outcomes; if there is an unmet demand for compact neighbourhoods and alternatives to driving, a shift towards compact development would be expected to produce a greater shift in travel behaviour than if there was not an unmet demand for these attributes.

A strand of research in Australia has disputed the environmental benefits of compact development. Troy (1996) argues that the reduced environmental impacts associated with compact development are over stated and that urban form is not a physical determinant of outcomes. Furthermore, any potential environmental benefits are deemed to be outweighed by the dis-benefit of amenity losses, as the majority of Australians are assumed to strongly prefer low density living. It is contended that the environmental impacts of low density development can be reduced through a number of measures, including increasing the fuel efficiency of vehicles, investment in public transport, increasing energy efficiency in dwellings, and encouraging composting and urban agriculture. Mees (2000) argues that a certain level of density and 'good' urban planning are necessary, but not sufficient, conditions for successful public transport in cities. Comparing the two relatively low density cities of Melbourne and Toronto, he argues that Toronto has significantly better public transport outcomes, not due to density or urban form, but due to superior public transport planning and investment decisions. Therefore, he asserts that emphasis should be placed on public transport planning and investment, rather than compact development, in order to achieve reduced emissions from transport.

For Troy, opposition to higher density living appears to be primarily motivated by concerns regarding the liveability of and preferences for high density living, as well as scepticism of anthropogenic climate change and its negative impacts. Although it may be possible in theory to reduce the environmental impacts of low density development through a number of measures, this does not invalidate the finding of many other studies that higher density neighbourhoods tend to have lower environmental impacts. Concerns over whether people may be willing to live in compact areas may have merit, but are best addressed through research that investigates preferences for housing and neighbourhood types, rather than a *prima facie* assertion without supporting evidence that most or all households prefer low density living. For Mees, compact development is deemed to be less important than transport investment in reducing emissions from transport. This is primarily argued through the selection of a small subset of data that supports this position, while neglecting a larger set of data that shows there is a clear relationship between density and emissions from transport, both within and across cities. Transport infrastructure and residential density both undoubtedly play a role in determining emissions from transport.

3.4 Urban form and household energy use

Urban form impacts not only emissions from travel, but also influences residential carbon emissions. Research has examined the influence of density and dwelling type on relative emissions between cities and within areas of cities using a variety of methods. Many factors influence the

relative household energy consumption of dwellings, making the relative emissions of development types less straightforward than for transport related emissions. Household energy use is influenced by dwelling floor area, the percentage of wall area exposed to outside air temperatures, dwelling age, local climate, build standard, the type and number of appliances in the home, heating and cooling methods, the number of residents, and household income (Anderson, Wulforth, & Lang, 2015; Glaeser & Kahn, 2010; Isaacs et al., 2010). Dwelling embodied energy is influenced by the construction materials as well as the life span of the dwelling (Anderson et al., 2015; Mithraratne, 2001). Given that these variables are usually not constant across neighbourhood and dwelling types, and that detailed data on residential energy use can be difficult to obtain, the relationship between urban form/density and residential energy use, all else being equal, is difficult to quantify and may vary from city to city. Furthermore, the relative emissions of compact and dispersed development may vary based on the location and types of dwellings being compared, as compact development could include a variety of dwelling types, including small standalone houses, duplexes, townhouses, and apartments.

Ewing & Rong (2008) examine residential energy use in the United States and present three causal pathways for the relationship between urban form and residential energy use: electric transmission and distribution losses, energy requirements of different housing types, and heating and cooling requirements associated with urban heat islands. Using a combination of several county level datasets, Ewing and Rong (2008) conclude that the average household's residential emissions (excluding transport) would be about 20 percent less if it lived in a compact county rather than in a sprawling county. Similarly, Pitt (2012) used household level data from the US to estimate residential energy use for space heating and cooling and found potential greenhouse emission reductions of approximately 23% between the most sprawling and most dense growth patterns.

Glaeser and Kahn (2010) examined the greenhouse gas emissions associated with residential development across 66 metropolitan areas in the United States. Four sources of emissions were analysed: home heating, driving, public transport, and electricity use. A variety of data was used to estimate emissions, including travel surveys, expenditure surveys, and census data. The strongest predictor of residential greenhouse gas emissions was the share of the metropolitan area population within 5 miles of the city centre, a measure of both centralisation and density, followed by population size and then January mean temperature. On average, transport was responsible for 53% of emissions, while electricity and home heating accounted for 34% and 13% of emissions, respectively. Climate played a strong role in determining emissions from electricity consumption and home heating, suggesting that climate plays a significant role in determining both overall

national emissions and the relative importance of household energy use and transport. When comparing emissions between the suburbs and the central city of a metropolitan area, residents of the central city had lower emissions in all but two metropolitan areas. Emissions from driving, home heating, and electricity all tended to be lower in central city than in suburb areas, although the magnitude of difference varied with city size, density and climate.

Senbel et al (2014) examined the emissions from transport, household energy, and dwelling embodied energy for residents living in four neighbourhoods in Vancouver, Canada, none of which were well served by public transport. The neighbourhoods represented four variations on compact development: high rise concrete towers, 4-storey wooden apartments, a mixture of townhouses and single family homes on narrow sections, and single family homes on 12 metre wide sections. Neighbourhoods were chosen that had similar income levels and house values. Transport emissions were derived from census and travel survey data. Household energy use data was obtained from the main utility provider in the region, which provided usage data for all the buildings types in the study areas. Embodied emissions were estimated using the emission factors of building materials. On average, electricity, embodied energy, home heating, and transport constituted 4%, 12%, 36%, and 47% of annual emissions, respectively. Relatively low emissions from electricity were due to the fact that the vast majority of electricity in the region is generated from hydroelectric dams. The neighbourhood with a mixture of townhouses and single family homes on narrow sections had 22% lower per capita emissions than the standalone home neighbourhood, while the high rise apartment neighbourhood had 70% lower emissions than the standalone home neighbourhood. These results suggest that high density housing has the lowest per capita carbon emissions when income is held constant, even in the absence of high quality public transport that often coincides with high density and may result in substantially reduced emissions from transport.

Norman, Maclean & Kennedy (2006) investigated the life cycle emissions associated with high and low density dwellings in Toronto. Transport emissions were derived from travel survey data and energy use was estimated using census and national energy use data. Embodied energy was estimated using input-output analysis of two case study developments. High density development had much lower emissions from transport and household energy use, and had less than half the per capita greenhouse gas emissions of low density development overall.

Duffy (2009) estimated the life cycle emissions associated with dwellings in the greater Dublin area for dwellings constructed between 1997 and 2006. Transport emissions were derived from travel survey data. Household energy use was estimated using results from the Energy Performance

Survey of Irish Housing, which surveys the energy use of dwellings by age, type, and occupancy rate. Embodied emissions were estimated using the emission factors of building materials. Dwellings built in the central city had the lowest per capita emissions, while dwellings on the city fringe had the highest per capita emissions; apartments had emissions that were 77% lower than standalone homes.

Perkins et al (2009) investigated the transport, dwelling embodied, transport embodied, and operational emissions associated with households living in three neighbourhood types (outer suburb, inner suburb, and central city) in Adelaide, Australia. While central city residents had much lower transport emissions than the other two groups, they had higher overall emissions due to higher dwelling operational emissions and lower dwelling occupancy rates. The inner suburb, which had medium housing density (30 dwellings per hectare) and consisted of predominantly two-storey detached houses, had the lowest overall per capita and per household emissions. The study had a relatively low sample size, with only 41 households in the city centre spread across three apartment buildings.

Myors (2009) examined energy use in Sydney for six dwelling types (high rise, mid rise, low rise, townhouse, villa, detached), by conducting energy use audits of 3,854 households in 45 buildings in the city. High rise apartments had the highest carbon emissions from energy per capita, while townhouses and villas had the lowest. These results have been used by opponents of high density development to argue that high density housing has higher emissions than low density development (Randolph & Troy, 2007). However, Rickwood (2009) as well as Beattie and Newman (2011) have criticised this conclusion, noting that the study did not control for income, with high rise developments disproportionately representing high income households, with apartments that had energy intensive amenities such as pools, spas, and central air conditioning and heating.

Rickwood (2009) examined household energy use for Sydney households using electricity and gas usage data from over 5,000 households. A simple regression was used to estimate the influence of 10 independent variables on household energy use. The variables that had the largest influence on household energy use were the number of people in the household, the number of appliances, and the use of gas heating. Energy use per capita in attached dwellings was 15 to 20 percent lower than in detached dwellings with the same number of bedrooms, after controlling for income and other variables.

Some studies have attempted to quantify the relative benefits of compact as opposed to dispersed development across a range of indicators. For example, Echenique, Hargreaves, Mitchell, & Namdeo (2012) investigated the relative benefits of compact and dispersed development patterns in England, using 26 indicators measuring the economic efficiency, resource use, social impact, and environmental impact of the spatial options. A compact development pattern had lower CO₂ emissions, lower air emissions from transport, and lesser amount of land developed, but the improvements over more dispersed patterns of development were relatively minor.

Heinonen & Junnila (2011) conducted a life cycle analysis of GHG emissions of average inhabitants living in different neighbourhood types in Finland. The study analysed all personal GHG emissions, including household, transportation, and consumption. Urban individuals had lower transport and household emissions as expected, but had higher overall emissions as compared to residents of suburban areas, as a result of air travel and higher levels of consumption among inner city residents. The results highlight the importance of income for GHG emissions, and show that income savings in one area can result in additional spending, and thus additional greenhouse gas emissions, in other areas. In addition, these results show that GHG emission profiles are highly heterogeneous; the results would differ greatly in other cities with different housing compositions, income distributions, and heating sources (Lambin et al., 2001).

In short, recent studies from the United States, Canada, Finland and Ireland suggest that higher density housing has lower combined travel and household emissions than lower density housing, with high density centrally located housing tending to have the lowest overall emissions. However, some Australian studies have indicated that medium density housing has the lowest overall emissions per capita. Across all four countries, emissions from operational energy use and transport have been found to constitute the bulk of emissions, with embodied energy representing between 8% and 30% of annualised emissions. Household size and income can be confounding variables, and must be controlled for in order to understand the relative emissions associated with a given household living in lower or higher density.

3.5 Co-benefits of compact development

Compact development also has wider benefits to society other than greenhouse gas reduction benefits; these include health benefits, reduction in the consumption of open space, and savings in government spending, especially on infrastructure.

A relatively recent and expanding strand of academic research examines the relationship between health and urban form. Urban form is thought to influence health by three primary means: by

influencing opportunities for active transport and thus physical activity levels, by influencing time spent driving and thus total activity levels, and by influencing exposure to outdoor urban air pollution (Frank, Saelens, Powell, & Chapman, 2007). The relationship between urban form and mode choice has already been discussed. To summarize, several characteristics of the built environment, such as population density, street connectivity, and land use mix have been associated with mode choice and hence the health related variable, rates of active commuting. Levels of active transport have in turn been associated with total physical activity levels, body mass index, and risk of mortality and cardiovascular disease (See Ding & Gebel, 2012 for a meta-review of this literature). For example, one study found that people who live in more walkable neighbourhoods walk 30 minutes more for transportation each week on average (Saelens, Sallis, & Frank, 2003) while other studies have found greater levels of total physical activity for residents of walkable neighbourhoods (Saelens et al., 2003). One survey found that each additional kilometre walked per day was associated with a 4.8% reduction in the odds of being obese, whereas each additional hour spent in a car per day was associated with a 6% increase in the odds of being obese (Frank, Andresen, & Schmid, 2004).

Exposure to urban air pollution from vehicles has been associated with numerous negative health outcomes, including heart disease, respiratory disease, lung cancer, asthma, and overall mortality rates (Brunekreef & Holgate, 2002; Kampa & Castanas, 2008). Chronic exposure to air pollution has been shown to vary both within areas of cities and between cities, suggesting that urban form plays a significant role in determining levels of and exposure to urban air pollution (Ewing, Pendall, & Chen, 2002; Jerrett et al., 2005; Stone Jr., 2008). Mixed land uses, higher density, and greater street connectivity are associated with significantly lower per capita emissions of nitrogen oxides and volatile organic compounds when controlling for income, age, vehicle ownership, and household size (Frank & Engelke, 2005; Frumkin, Frank, & Jackson, 2004). While residents of compact neighbourhoods may contribute less to localised air emissions, they are often exposed to more pollutants than their counterparts living in lower density areas (Schweitzer & Zhou, 2010).

A frequently cited disbenefit of sprawl is excessive consumption of open space, although the extent to which this is the case, and its cause, is debated. For example, Weng (2007) shows that urban expansion results in habitat fragmentation and Irwin & Bockstael (2004) argue that land use policies are an important determinant of the degree of conversion from open space to urban land use. Excessive consumption of agricultural land can be due to an undervaluation of agricultural land, and excessive consumption of open space can be a failure to accurately value its environmental and social benefits (Bertaud, 2015; Walsh, 2007). Other studies have noted that

agricultural land uses consume significantly more land and are significantly more responsible for habitat loss than urban land uses (Lambin et al., 2001).

Another potential co-benefit of compact development is decreased infrastructure costs for municipalities, and thus their residents. Carruthers & Úlfarsson (2008) examined the impact of the built environment on public expenditure for every county in the United States. Spending was calculated for ten categories: total direct expenditure, education, fire protection, housing and community development, libraries, parks and recreation, police protection, roadways, sewerage, and solid waste management. The density of developed land was associated with less spending for five of the measures of spending (total direct, education, parks and recreation, police protection, and roadways), while it was associated with increased spending for housing and community development. Having a greater extent of developed land, measured as the percentage of land area that is developed while holding land area constant, was associated with increased spending for 8 out of the 10 measures of spending. Overall, the results suggest that low density development costs more for local governments than high density, compact development. Similar results have also been found in other countries. For example, Hortas-Rico & Solé-Ollé (2010) investigated the costs of providing local public services in Spain and found that low density development leads to greater costs of providing public services. Trubka, Newman, & Bilsborough (2008) attempted to quantify the infrastructure, transportation, greenhouse gas emissions, and health costs associated with infill as opposed to greenfield development for Australia and concluded that there are substantial cost savings associated with infill rather than greenfield development.

3.6 Preferences for compact development

The housing market is not solely governed by the forces of housing supply and demand, as these forces are substantially mediated and altered by controls on the supply of housing, lending programmes, and the nature of housing as a durable and sticky good⁴. Moreover, the housing market is also substantially influenced by non-housing factors, such as the transportation system, which is primarily the result of strategic government investment rather than market forces. As a result, individual utility maximisation by housing ‘consumers’ in the context of housing choice is subject to major market ‘imperfections’. In reality, the market for housing differs substantially from many other markets in ways that may inhibit the ability of the market to reach equilibrium. Housing is an expensive and durable good; as a result the houses within an urban market reflect not only the demands and planning controls of today, but also those of previous decades or

⁴ Refer to Chapter 2 for a review of the planning context within Wellington City, the case study area.

centuries. The construction of new dwellings and renovations of existing dwellings are the means by which supply adjusts to meet current demand. The construction of new dwellings can be considered a long term adjustment and the renovation of existing dwellings a short/medium term adjustment, but both of these work slowly given the durable nature of housing and the time needed to construct new dwellings. Because there are substantial transaction costs associated with moving, household's housing choices are sticky – a choice made years or decades ago may no longer reflect a household's preferences. Residential relocation is accompanied by high monetary and non-monetary transaction costs, which will discourage many households from moving, even if their current dwelling is not the one with the highest utility in the local housing market (Rothenberg, 1991). Even among households who do choose to move, there are barriers to achieving the dwelling with the highest utility in the current marketplace. This may be due to the high cost of the search process, imperfect information, or because of time lags: not all dwellings with the desired attribute combinations are on the market at any given time and waiting for the ideal home to become available may take a period of waiting which is not perceived to be worth the benefit.

In the context of studies of compact versus sprawling/dispersed development, the question of interest is whether market failures in the housing market result in cities that are more or less compact than would otherwise be the case, and the extent to which this impacts environmental, social, and economic outcomes. Many researchers have argued that the market for housing is to varying extents distorted by zoning restrictions, lending restrictions, tax incentives, and subsidies, all of which tend to favour low density, automobile oriented development, and that as a result current supply and levels of sprawling development may not be in line with current consumer preferences (Ewing, 1997; Levine, 2006). As a result, they have used stated preference approaches to assess demand for compact development.

Because of the limitations associated with a revealed preference approach to studying housing preferences, many previous studies have used a variety of stated choice methods in order to gain an understanding of housing, neighbourhood, and transport preferences. These studies vary by the stated choice method used, the inclusion of housing, neighbourhood and transport components of preferences, and in terms of the findings. Eliciting preferences for housing and neighbourhood preferences is not a straightforward process, for several reasons. Any one attribute of a dwelling is bundled with other attributes, including non-residential attributes (such as the location of work, family, and friends). These attributes are often bundled in typical baskets of attributes that make it difficult to determine which is most influential in the choice decision (e.g.

standalone houses often have large sections and off-street parking and apartments do not) (Ewing, 1997; Lovejoy et al., 2010).

Levine & Frank (2007) used a stated preference approach to investigate preferences for low-density, auto-oriented neighbourhoods as opposed to compact, walkable, and transit-oriented neighbourhoods in Atlanta, Georgia. Respondents were recruited from across the City, using a door to door recruitment method with areas stratified based on income, household size, and residential density (n=1,455). The research attempted to gauge preferences for neighbourhoods without a price element, on the assumption that if auto-oriented and compact, walkable neighbourhoods were both sufficiently supplied they would be comparable in price. The study used a choice-based conjoint approach, presenting respondents with several two way trade-offs that were rated using a 10 point Likert scale. These included (among others): walkability versus commercial–residential land use separation; commute distance versus residential density; availability of alternatives to the car versus dwelling size; and accommodation of cars versus accommodation of pedestrians and cyclists. Principal-component analysis was used to combine the responses relating to each component of compact development to create a scale of overall preference for compact development. Significantly more respondents had a preference for compact, walkable neighbourhoods than those who currently live in that neighbourhood type, with the authors interpreting this as evidence of systematic undersupply of compact development relative to current demand. The authors also suggest that land use regulations played a central role in the undersupply of compact development in Atlanta, Georgia. Frank et al. (2014) used a very similar methodology to Levine & Frank (2007) to investigate the demand for walkable neighbourhoods in Vancouver and Toronto, Canada. The study found similar results to the earlier study, with about 10 to 30% of the residents currently living in automobile oriented neighbourhoods actually preferring walkable neighbourhoods. Given that residents of walkable neighbourhoods walk more, the authors conclude that policies to increase the supply of walkable neighbourhoods can both satisfy preferences and have positive impacts in terms of health enhancing behaviours.

The Levine and Frank methodology adds to the literature by confirming the intuitively reasonable hypothesis that an individual's current neighbourhood of residence is not always reflective of current preference, showing that in several North American cities there is an unmet demand for walkable neighbourhoods, all else being equal. However, the Levine and Frank study has several limitations. Firstly, the methodology gauges preferences for compact development with trade-offs between two neighbourhoods: a more walkable neighbourhood characterised by smaller

standalone houses on small sections, within a 10 minute walk of a number of destinations and 5 kilometres to work, and an automobile oriented neighbourhood characterised by larger homes on large sections, with no destinations in walking distance and 25 kilometres to work. This dichotomy, which is necessary when using this type of survey design, obviously fails to encompass the diversity of neighbourhood types in modern cities. Furthermore, the compact neighbourhood described in the study is relatively low density, and attractive in terms of destination accessibility, and these characteristics may have led the study to overstate demand for compact development compared to a study that described less attractive compact development (e.g. apartments with no outdoor space). This choice was somewhat unrealistic, as in most large cities, living within 5 kilometres of the city centre /work would almost certainly entail living in multi-unit housing or paying more than standalone dwelling 25 kilometres from the city centre / work.

Handy, Sallis, Weber, Maibach, & Hollander (2008) assessed trends in support for traditionally designed neighbourhoods using a nationally representative sample of American households in 2003 (n=5,873) and 2005 (n=12,630). Traditionally designed communities were described as having a mix of housing types, streets designed for pedestrians and cyclists as well as cars, and being walking distance to local destinations. The study found increasing support for traditionally designed communities, increasing from 44% in 2003 to 59% in 2005. 44% of respondents in 2003, and 50% of respondents in 2005, said they would like to live in a traditionally designed community. This research is significant in that it attempts to measure not only the demand for compact neighbourhoods, but also public support for compact development more generally, which may be necessary for policy change. In principle, some respondents may support compact development in the abstract, but not prefer it themselves. Nonetheless, preference for compact development and support for compact development appear to be closely linked.

Cao (2008) investigated the extent to which alternative development is undersupplied in California by surveying the priorities of recent movers when choosing neighbourhoods. Eight neighbourhoods were chosen to vary by urban area size, area within California, and conforming to two neighbourhood typologies: traditional neighbourhood design and automobile oriented design (n=594). Neighbourhood preferences and priorities placed on these preferences were determined by asking respondents to rate how important 34 neighbourhood characteristics were when they chose their residence using a four point Likert scale. Housing costs and neighbourhood safety were found to dominate residential choice decisions, with destination accessibility being much less important than these and other attributes, including attractiveness and quietness of the neighbourhood. This research does not invalidate other research showing an unmet demand for

compact development, but shows that preferences for compact development are unlikely to be realised unless higher priority factors, such as price and safety, are comparable between compact and dispersed neighbourhoods. This research makes a contribution to the literature by demonstrating that it is not only preference for compact development that is important when determining whether compact development is undersupplied, it is also the degree to which this particular characteristic of the built environment is prioritised when choosing where to live.

Howley (2009) assessed the motives, preferences and future intentions of residents of central Dublin City. The study asked 270 inner city respondents what dwelling type (detached, semi-detached, terraced, or apartment) they envisaged themselves living in in the future, their satisfaction with urban living, and the benefits they derive from urban living, and used the results to create a logit model of residential mobility. Results indicated that the majority of residents living in high density areas had an intention to move to lower density locations, and that life cycle stage and satisfaction with dwelling and neighbourhood were the most significant predictors of intended future mobility patterns. A drawback of this survey design is that preferences for dwelling type are like to be somewhat confounded with preferences for other neighbourhood and housing attributes that vary with density and distance to the central city, and it is difficult to determine what exactly is driving urban residents to intend to move to lower density locations, and what factors could encourage them to continue to live more centrally in the future.

Lewis & Baldassare (2010) analysed residents attitudes (n=3,023) towards smart growth in five states in the western United States (California, Texas, Arizona, New Mexico, and Nevada), using four trade-off questions similar to those used by Levine and Frank (2007). The study examined pairwise correlations between preferences for four aspects of compact development, and found that correlations were weak, with preferences often being contradictory. For example, for respondents who stated a preference for a smaller house and shorter commute, 61% said they would prefer a low density, automobile dependent neighbourhood, suggesting that smart growth means different things to different people and that people may support certain aspects of smart growth rather than viewing smart growth as a single package of attributes.

Lovejoy et al. (2010) used the reported level of neighbourhood satisfaction in combination with perceptions of the neighbourhood environment as a reflection of preferences for neighbourhood types among residents (n=1,682) of traditional (grid layout, higher density) and suburban (curvilinear street patterns, lower density) neighbourhoods in California. Satisfaction with neighbourhood characteristics was slightly higher for residents of walkable communities, after controlling for socio-demographic and neighbourhood characteristics. The strongest predictors of

neighbourhood satisfaction, for residents of both neighbourhood types, were perceptions of the attractive appearance and safety of their neighbourhoods. Suburban residents, contrary to common wisdom, did not derive more satisfaction from the availability of parking, quiet, large sections, cul-de-sacs, low density, and school quality than traditional neighbourhood residents. Traditional neighbourhood residents did not derive more neighbourhood satisfaction from high density or proximity to destinations, but did derive more satisfaction from liveliness than suburban residents. Similarly to Cao (2008), this research demonstrates that factors unrelated to urban form can dominate satisfaction and neighbourhood choice, and that preferences for compact development may be unlikely to be realised unless higher priority factors are comparable between compact and dispersed neighbourhoods.

Discrete choice experiments (DCE) are a type of stated choice method that allow researchers to estimate preferences for a variety of attributes of a good and gain an understanding of the relative importance of these attributes in choice decisions (Adamowicz, Boxall, Williams, & Louviere, 1998)⁵. DCEs are based on random utility theory. The theory holds that a rational decision maker, when presented with two or more alternatives, will choose the alternative that provides the highest level of utility or satisfaction at the time a choice is made and that the utility of a good is a sum of the utilities of its component attributes (plus a random or unexplainable component) (Louviere, Hensher, & Swait, 2000). DCEs were developed in the marketing and transportation research areas but are now extensively used in environment, public health, and planning studies (Kanninen, 2007; Ryan, Gerard, & Amaya-Amaya, 2007). The studies described below have used a DCE method to estimate preferences for housing, neighbourhood, and transport, with particular regard to preferences for compact development. They are an improvement on the previous methods described in that they allow for estimation of several components of preferences simultaneously, quantification of the relative importance of attributes, and can allow for an estimation of willingness to pay for attributes. Latent class multinomial logit models (LC MNL) are a type of multinomial logit model that allow for the identification of market segments as a means of accounting for the heterogeneity of preferences across the population. Unlike other market segmentation methods, the LC MNL approach is not dependent upon a predefined specification of preferences or lifestyle segments. Instead, class membership and class profiles are simultaneously determined by respondents' choices and/or behaviour, and may also include other

⁵ Discrete choice experiments are sometimes referred to as the 'choice-based conjoint analysis method' for example in Hoshino (2011) but prominent authors in the field advocate for using the former name (Louviere, Flynn, & Carson, 2010).

individual level characteristics such as demographics. In a LC MNL, class membership is not assumed to be known and is treated as probabilistic.⁶

Molin, Oppewal, & Timmermans (1996) estimated preferences for newly constructed medium to high density housing in the Netherlands using a traditional mnl model. The study surveyed residents intending to move within the next five years (n=184). The study examined preferences for tenure type, number of bedrooms, interior space, private outdoor space, parking, dwelling types in the neighbourhood, public outdoor space, distance to local destinations, and price. The study found that low rise buildings were much more attractive to potential residents than high rise buildings. Respondents were also highly price sensitive, preferred living near destinations, and valued private outdoor space (public green space was not statistically significant). The study demonstrates that preferences for compact development are often dependent on a combination of several housing and neighbourhood attributes, and that understanding these preferences in principle can help to provide compact development that is most desirable to potential residents.

Walker & Li (2007) estimated preferences for housing types, neighbourhood density, and destination accessibility among residents of Portland, Oregon (n=507) using an LC mnl model. The study examined preferences for 19 variables related to house type, housing tenure, neighbourhood attributes, and destination accessibility⁷. Three preferences groups were found: a suburban oriented (prefer larger houses, parking, schools), a transit oriented (prefer lower travel time, larger lot size, standalone houses), and a high density oriented (prefer smaller lot sizes, shorter walk time to shops, and an urban setting). There was a fairly even split between the three groups: 43% in the suburban, 27% in the transit oriented, and 27% in the high density oriented group. The study demonstrates that there is a range of preferences with regard to housing, neighbourhood, and transport accessibility. Understanding the heterogeneity in these preferences can shed light on the unmet demand for housing and neighbourhood types and the types of houses and neighbourhoods that would be most attractive for subsets of the population.

Liao, Farber, & Ewing (2015) estimated preferences for compact, walkable, and transport oriented neighbourhoods in Utah using an LC MNL model. The study examined preferences for street design, parking, house types in the neighbourhood, distance to transit, distance to work, and

⁶ Refer to Chapter 5 for a further discussion of discrete choice experiments and multinomial logit models.

⁷ These attributes were: dwelling type, dwelling size, lot size, parking, price, dwellings in neighbourhood, land use types, age of dwelling, types of shops nearby, local parks nearby, bicycle paths, school quality, neighbourhood safety, shopping prices, walking time to shops, bus time to shops, travel time to work by auto, and travel time to work by transit.

distance to local destinations among residents (n=1,053) of four Utah counties. Notably, the type of dwelling was excluded as an attribute and prices were expressed as a percentage of current dwelling costs. 40% of respondents showed a preference for compact neighbourhoods; they had a preference for being close to work, close to destinations, close to transit, a mix of house types in the neighbourhood, and pedestrian/cyclist oriented streets but had a preference for off-street parking. They were willing to pay more for these attributes as compared to less accessible lower density housing.

Tian, Ewing, & Greene (2015) estimated preferences for smart growth among residents (n=1,227) of the Salt Lake City region, Utah. The study examined preferences for street design, parking, dwelling types in the neighbourhood, distance to transit, and distance to local destinations using a mixed MNL model. The study was similar to that of Liao et al., (2015) and also excluded the type of dwelling as an attribute and expressed home prices as a percentage of current dwelling costs. However, it departed from the other study by analysing preferences among different life cycle cohorts, as defined by age and presence of children in the household. Different life cycle cohorts were found to have different preferences, with young families with children placing a higher value on neighbourhoods with only single family homes and empty nesters preferring a mix of housing types in the neighbourhood.

Lu, Southworth, Crittenden, & Dunham-Jones (2014) also estimated preferences for smart growth neighbourhoods among residents across the USA using an LC MNL model. The study used data from the 2011 NAR community preference survey, a nationally representative online survey conducted by the National Association of Realtors on housing and neighbourhood preferences (n=2,071). The study examined preferences for lot size, destination accessibility, commute time to work, and public transport access. 19% of respondents were highly likely to choose compact development and 23% were somewhat likely to choose compact development, with the remainder preferring dispersed/sprawling development. The study did not include a price component to the experiment, making it unclear whether those with a preference for compact development are willing to pay more in order to obtain these attributes. Nor did it include house type as an attribute, making it unclear whether those with a preference for destination accessibility and higher accessibility are willing to live in higher density housing types in order live in their preferred neighbourhood type.

3.7 Social impacts of compact development

While compact development may result in positive environmental impacts and have co-benefits such as health benefits from active transport, compact development can also potentially influence other social outcomes. These include the unequal accrual of the benefits of compact development, reduced affordability of cities and neighbourhoods, and reduced economic and racial diversity of cities and regions. A considerable literature has investigated how factors such as public transport investment and the revitalisation of central city areas may influence social outcomes, such as displacement of existing residents, affordability, and economic and racial segregation. For a review of the international literature on the topic, see Zuk et al (2015). A review of New Zealand research on the topic follows.

Morrison (2011) argues that the growth of a creative economy in Wellington City and concurrent rise in the central city population has resulted in increased suburbanisation of less advantaged groups. It is argued that the benefits of a creative city, including a vibrant central city and a concentration of professional and creative jobs, accrue disproportionately to higher income groups and the well-educated, who are much more likely to live centrally. At the same time, it is argued that the creative city results in an increasing rent gradient, which may drive those with lower incomes to live in the surrounding region in search of lower housing costs, where they face increased commuting costs. Friesen (2009) similarly argues that the reurbanisation of the Auckland CBD and surrounding suburbs has resulted in gentrification and displacement. Between 1976 and 2006, the Pacific population of central Auckland dropped by half, while the number of European residents and students increased considerably.

If more advantaged populations tend to live in the most accessible neighbourhoods, then they are likely to disproportionately gain health benefits from active transport, whereas less advantaged populations living in less accessible neighbourhoods may face higher transport costs and adverse health outcomes associated with decreased physical activity. McKim (2014) argues that those with higher incomes in New Zealand are more likely to live near their workplace, and thus more likely to commute by active transport. Conversely, Buchanan et al (2006) found that in Christchurch City, those living in high deprivation areas were less likely to commute by car, and had shorter commutes than residents of low deprivation areas⁸. Witten et al (2012) investigated the relationship between neighbourhood characteristics and physical activity for residents living in more and less

⁸ The New Zealand deprivation index is the most widely used measure of poverty or economic hardship in the country. The index ranks areas in terms of relative deprivation based on nine variables: income, housing tenure, single-parenthood, unemployment, lack of educational qualifications, crowding, lack of access to a telephone and/or a car. A higher index score means greater deprivation.

deprived neighbourhoods in Auckland, Wellington and Christchurch cities. Higher levels of deprivation were moderately correlated with higher dwelling density (0.37), density of neighbourhood destinations (0.39), and street connectivity (0.42), variables associated with increased levels of physical activity, all else being equal. However, consistent with Morrison's hypothesis, residents of more deprived neighbourhoods (i.e. 'deprived' groups) did not have statistically higher levels of transport related physical activity, and actually had significantly less leisure related physical activity, as compared to residents living in less deprived neighbourhoods. These differing results across studies may be partly due to the influence of urban structure on social outcomes; Wellington is a highly monocentric city with a concentration of jobs in the central city whereas in Christchurch the most common commute is between suburbs.

3.8 Impacts of planning on urban growth patterns

Urban planning as a practice exists largely in order to control the negative externalities that are frequently associated with urban life, such as the negative impacts of industry on nearby residents. As such, urban planning is usually either implicitly or explicitly assumed to be the preferred solution to the negative externalities associated with low density development and the excessive outward expansion of cities. However, urban planning has also been implicated as a key cause of sprawling development patterns, and planning rules have also been claimed to have other negative external effects, such as increased housing costs (The New Zealand Productivity Commission, 2012). Two common planning tools used to control the pattern and spatial extent of development are zoning rules and urban growth boundaries. Another proposed solution to low density development and automobile dependence is integrated land use and transport planning, which seeks to address failures associated with planning urban development and transport separately.

Glaeser & Kahn (2003) argue that smart growth advocates may in some cases unwittingly induce sprawl when urban areas restrict development through zoning rules intended to achieve compact development. In these cases, districts on the fringe rarely have an incentive to restrict housing in their districts; with the result that cities with smart growth oriented zoning rules push development further from city centres in a leap frog pattern across urban boundaries.

Talen (2012, 2013) argues that conventional approaches to zoning used in much of the United States cause sprawl through four main mechanisms. Separating commercial and residential land uses encourages driving and makes walking and cycling less viable. Imposing minimum lot sizes for residential development decreases residential density and increases distance between destinations. Requiring front setbacks in residential areas further decreases density and discourages

walking. Encouraging automobile oriented streets by requiring cul-de-sacs, prohibiting straight streets, and mandating parking requirements creates an environment that encourages driving and discourages alternatives. Levine (2006) similarly argues that predominant zoning rules throughout much of the United States dictate low density development. Levine argues that many of these rules are the result of local residents' desires to ensure exclusivity and preserve current neighbourhood character. Evidence from preference studies (Levine & Frank 2007) is used to argue that zoning constrains development, resulting in lower density than if development took place in a more open market where preferences could be more easily realised.

Shoup (2005) provides an in-depth analysis of one planning rule, minimum parking requirements, which are almost universal in Western countries and mandate on-site parking for both residential and commercial activities. While minimum parking requirements were initially created in order to minimise the negative externalities associated with shortages of car parking, Shoup argues that minimum parking requirements introduce several negative externalities, including increased costs of land for housing and commercial uses, and excessive driving. This is because mandating parking results in over-supply and over-consumption of parking relative to what would be demanded if parking costs were subject to the forces of supply and demand.

Urban containment policy, also known as urban growth boundaries, is a planning tool that has been used in an attempt to limit the outward expansion of cities and its perceived negative effects. Examining 35 of the largest metropolitan areas in the United States, Nelson & Sanchez (2005) argue that urban containment policies are effective at limiting consumption of land. Some argue that urban containment policies in themselves can produce negative outcomes by artificially increasing the cost of housing (Grimes & Liang, 2008), while others have taken a more nuanced approach, acknowledging that planning rules such as urban containment policies have both benefits and costs for society (Nelson, Sanchez, & Dawkins, 2007).

Integrated land use and transport planning has been proposed as a means of ensuring that transport and urban development occur in a planned fashion without unintended consequences. Integrated land use and transport models consider transport and urban form simultaneously, and allow planning practitioners to gain an understanding of the likely effects of transport infrastructure investments on land use, and vice versa. This is in contrast to traditional planning approaches, which tend to consider transportation and land use planning separately (Waddell, 2002).

3.9 New Zealand research

The first significant research into housing and neighbourhood preferences in New Zealand was completed in 1977 by the National Housing Commission. The creation of the National Housing Commission was mandated by the National Housing Commission Act 1972, under the Third Labour Government of New Zealand, in order to inquire into the housing needs of New Zealanders and provide advice to the Minister on housing issues (New Zealand Government, 1972). The commission investigated housing preferences in New Zealand, and surveyed a representative sample of 2,000 individuals from across the country. With regard to preference for neighbourhood and area types, 1.6% of respondents stated a preference for living in the city centre, 33.6% stated a preference for living in a city suburb, and the majority (64.8%) stated they would prefer to live in a town or rural area. 87% of respondents stated that their preferred dwelling type would be a standalone house, 13% preferred a townhouse, and 0.5% preferred an apartment. 52.5% said they would dislike having townhouses next door to their home and 86% said they would dislike having apartments next to their home (McMurray & Duc, 1977).

Morrison & McMurray (1999) examined the rise of central city apartments in Wellington City, a dwelling type which saw exponential growth in the 1980s and 1990s. Residents of both central city apartments (n=67) and the wider city (n=72) were asked to rate on a Likert scale factors that were important in their choice of current residential location. The study found that apartment dwellers had similar priorities to residents living in inner suburbs when choosing where to live, and the choice of apartments was driven by a demand for location rather than apartments as a dwelling type. Nevertheless, the majority of respondents were still found to have a preference for low-density detached dwellings.

Haarhoff et al. (2012) conducted in-depth qualitative interviews of 84 residents of three medium density developments in Auckland City. While the majority of residents spoke positively about the location and destination accessibility of their medium density housing, nearly three-quarters intended to relocate to low density standalone housing in the future, suggesting that preferences for low density housing are still strong in New Zealand.

Betanzo (2012) investigated neighbourhood and travel preferences in two Wellington neighbourhoods, one characteristic of 'traditional' neighbourhood design (n=53) and one characteristic of sprawling suburban design (n=77). Elements of 'traditional' neighbourhood design included higher than average densities, a high proportion of mixed land uses, interconnected streets, and pre WWII construction. Neighbourhood preferences were determined using the Levine and Frank method. Results suggested that 94% of residents of the traditional

neighbourhood lived in their preferred neighbourhood type, while only 64% of the sprawling suburban neighbourhood lived in their preferred neighbourhood type (30% of suburban neighbourhood residents preferred a traditional neighbourhood), suggesting that there may be an unmet demand for traditional neighbourhoods in Wellington. Neighbourhood location was closely related to both travel preference and usual travel mode. On average, traditional neighbourhood residents preferred alternatives to driving, felt that there were few barriers to using alternatives, and used alternative modes for most trips. In contrast, suburban neighbourhood residents were almost evenly split between those preferring to drive and those preferring alternatives to driving. However, 80% of suburban neighbourhood residents drove for most trips, suggesting that neighbourhood of residence has a strong impact on VKT and the ability to use a preferred travel mode. The study's small sample size and limited geographic range makes it difficult to generalise the results to Wellington City as a whole.

O'Fallon & Wallis (2012b) conducted a study of residential preferences (specifically for inner city living) and travel behaviour among residents in Wellington and Auckland, New Zealand (n=666). Residential preference was determined using two Likert scale questions: "I prefer to live in the inner city to living in a suburb" and "I'd rather live in a suburban neighbourhood, even if it meant I had to drive to shops, schools and services". Eighteen percent of respondents were identified as having a preference for urban living while the remaining 82% had a preference for suburban living. Twenty percent of suburban residents were identified as preferring to live in the inner city, while 28% of inner city residents were identified as preferring to live in the suburbs, suggesting that those with both suburban and urban preferences had similar success finding their preferred dwelling in the current market. Urban residents were found to walk considerably more than their suburban counterparts. Preference as well as neighbourhood of residence was found to be an important factor in travel mode choice, with suburban residents who had a preference for urban living driving less than other suburban residents who preferred suburban living (but still driving more than inner city residents).

Witten et al. (2012) investigated levels of walking from active transport and leisure, controlling for self-selection, among residents living in more and less walkable neighbourhoods in Auckland, Wellington, and Christchurch cities. 12 neighbourhoods, stratified by walkability and demographics, were selected for each City, with a total of 2,033 respondents. Walkability was defined using five measures: destination accessibility, street connectivity, dwelling density, retail floor area ratios, and land use mix. Preference for neighbourhoods was assessed using the Levine and Frank methodology. Preferences were relatively evenly split among those preferring more and less walkable neighbourhoods; 42.3% preferred low density, car oriented neighbourhoods, while

51.5% preferred mixed use, walkable neighbourhoods⁹. Each of the walkability measures had an association with physical activity levels after controlling for self-selection and demographics; dwelling density had the strongest apparent impact on levels of active transport, and street connectivity had the strongest impact on levels of leisure physical activity.

Howden-Chapman, Hamer-Adams, Randal, Chapman, & Salmon (2015) and Preval, Chapman, & Howden-Chapman (2010) conducted a survey of sentiments about urban form and planning using a nationally representative online sample of New Zealand residents in 2009 (n=3,244) and 2015 (n=3,080). When asked their most preferred dwelling type, over 80% of the 2015 sample said they would prefer a standalone house. However, when asked to make a trade-off between more residential space and a shorter commuting time, 26% said a shorter commuting time was more important than residential space. In 2015, about 10 percent more respondents said that having a short commute was more important than residential space, suggesting that preferences for compact development may be increasing. Interpreting responses to this question, however, is somewhat difficult as it could be interpreted differently by different people; trading less residential space for a shorter commute could mean an apartment in the central city instead of a standalone house in an inner suburb or it could mean a small standalone house in an inner suburb instead of a large standalone house on the edge of the city.

3.10 Conclusion

This chapter has reviewed research on the causes of sprawling/dispersed development patterns, the environmental, social, and economic benefits of compact as opposed to sprawling development patterns, and potential policy solutions to promote compact development patterns. Despite many households' predilection for low density housing, compact development patterns show clear benefits over sprawling development patterns; these include: health benefits, reduced greenhouse gas emissions, decreased costs of service provision, and preservation of open space. There are many different preferred solutions to discourage dispersed/sprawling development, including pricing mechanisms and zoning rules, and the preferred solution is to a large extent dependent on the conception of the problem. Despite the research on these clear benefits, urban development in developed countries has generally followed a pattern of decreasing density over the last 70 years. The question of how to achieve compact development in practice is a question that is somewhat more practical in nature and has received less attention in academic research.

⁹ An equal number of residents were selected from more and less walkable neighbourhoods, implying that if all individuals lived in their preferred neighbourhood type 50% of the sample would prefer walkable neighbourhoods.

Zoning rules, which are generally viewed as tools to internalise negative externalities and improve the public good, have been shown to perversely increase sprawling development in many cases. Two common barriers to achieving compact development in practice are a concern that a shift towards compact development is not supported by demand and public opinion, and difficulties with implementing successful policies to achieve the desired outcomes (Downs, 2005; Grant, 2009).

Understanding consumer preferences for compact development is an important component of a shift towards planning for compact development for several reasons: because current levels of compact development are often not reflective of preferences, a shift towards compact development must be justified at least partly by demand in a market oriented economy, public officials often face significant opposition from the public, and VKT reduction goals expected from compact development may not be achieved if there is not a preference for alternatives to driving.

Preferences for housing, neighbourhood, and transport are complex and multifaceted, so it is no surprise that many different approaches have been used to analyse these preferences. The methodological approach used and the factors that are considered in studies are largely determined by the research question of interest to a particular discipline or in a particular geographic area. Research on preferences is influenced by the solution that is preferred by the researchers; areas of focus include traditional neighbourhood design, new urbanism, smart growth, housing density, walkable neighbourhoods, and transport oriented design. While in most cases these terms encompass many of the same attributes of housing and neighbourhoods, some research can be subject to omitted variable bias, where the exclusion of key explanatory variables can bias the conclusions of the research.

One limitation of much of the previous international research on preferences for compact development is that most of these studies have largely looked at preferences for neighbourhoods in principle (assuming that price and other factors are held constant), and have limited consideration of the impact of dwelling type, price, and proximity to the central city on preferences. Research has also tended to focus on preference for compact development in the form of standalone homes, assuming that prices for standalone homes in compact, centrally located neighbourhoods would be equal to prices for standalone homes in lower density, less centrally located neighbourhoods. Similarly, much research has gauged a preference for compact neighbourhoods without considering how distance the centre city impacts preferences for these types of neighbourhoods. Conversely, economic literature on the causes of sprawl has demonstrated that housing prices are to a large extent determined by destination accessibility and housing related attributes (especially size and thus density). Under this paradigm, the choice of

higher density areas is largely a result of a trade-off between destination accessibility and housing attributes. A choice of centrally located compact development then, entails either a choice of higher density, smaller housing or paying more than an equivalent dwelling further from the central city. Future research on housing, neighbourhood, and transport preferences could shed light on the market for compact development by presenting scenarios or ‘choices’ which are more analogous to real world trade-offs between price, destination accessibility, and dwelling type.

New Zealand presents an interesting case for researchers; in the last 50 years it has followed a development pattern similar to the rest of the Western world, but is somewhat set apart from its counterparts in Europe and North America because it lacks the legacy of cities with compact urban areas that were developed in the centuries before the dominance of the car. New Zealanders also have a history of a strong preference for living in standalone houses with sections. Following international patterns, travel mode and vehicle kilometres travelled in New Zealand are closely related to residential location, suggesting that urban form plays a critical role in determining transport greenhouse gas emissions, as well as the health effects from active/inactive transport. However, the relationship between neighbourhood and transport mode is complex and influenced by other factors than density and urban form, as can be seen by trends over time. For example, in 1975 65% of trips to work were made by car, as compared to 82% in 2012, while changes over this time period saw a rise in urban living and an increase in medium and high density housing (McMurray & Duc, 1977; Statistics New Zealand, 2013).

Relatively little research has been done within a New Zealand context on preferences for urban housing types, despite the fact that the country is experiencing rapid urbanisation and growth in inner city living. Previous research in New Zealand has investigated preferences for two compact development types: high density central city living, and traditionally designed neighbourhoods; the small amount of extant research suggests that the latter form is more attractive to many households. While research suggests that most New Zealanders have a clear preference for standalone houses on large sections, they also have a preference for destination accessibility and are accustomed to commute times that are very short by international standards (Ministry of Transport, 2014; O’Fallon & Wallis, 2012a). However, increasing housing costs and continued population growth in the country’s main urban areas are making it increasingly difficult to satisfy both of these preferences simultaneously given financial restraints (The New Zealand Productivity Commission, 2012). The trade-offs that households are willing to make between housing type, destination accessibility, and price are relatively unknown in a New Zealand context. A greater understanding of this relationship can provide insight into the role preferences can play in achieving environmental outcomes and accommodating future population growth.

CHAPTER 4

Impacts of survey recruitment and completion mode on responses

4.1 Introduction

In recent years there has been an exponential growth in the use of technologically assisted survey techniques across disciplines conducting human subject research. This technological change is impacting all types of survey distribution methods and survey types, with a particular impact on quantitative survey methods. Computer-assisted telephone interviews are replacing traditional telephone interviews, internet browser based surveys are replacing pen and paper surveys, and computer-assisted personal interviews are replacing pen and paper personal interviews. Research across social science disciplines investigates how these technologically assisted survey techniques differ from their traditional counterparts and seeks to determine whether traditional or technologically assisted survey modes are more advantageous for researchers (See Greenlaw & Brown-Welty, 2009; Nulty, 2008; Shih & Fan, 2008 for reviews). With regard to which survey techniques are the most reliable and have the least bias, the results from these studies are far from conclusive; some studies have found no significant differences across survey modes while others find varying differences. The take home message from these studies is that there are substantial differences between the type and nature of biases encountered when using traditional and technologically assisted techniques, but at this point neither technique is a clear winner in terms of collecting superior data. What is clear is that technologically assisted survey techniques seem destined to eventually replace their predecessors, due to the inherent advantages they offer to researchers. These include greatly reducing data entry and processing costs, the ability to increase survey complexity and tailor questionnaires to respondents, and to more quickly gather and collate results. Given this reality, the main question for researchers is becoming not whether to use traditional or technologically assisted survey techniques, but rather which technologically assisted survey technique offers the most benefits for any given research project.

The current study investigates the relative merits of two technologically assisted survey techniques: an email distribution with internet completion and a door to door recruitment with tablet completion technique, in the context of a stated choice survey regarding housing and neighbourhood preferences in Wellington, New Zealand. The study consists of a stratified sample with three recruitment mode/response mode groups: one recruited via an online panel with online (internet) responses, one recruited via a door to door recruitment method with online responses, and one recruited via a door to door recruitment method with in-person responses using a tablet computer. This analysis makes a contribution to the literature by holding the survey presentation constant while varying the survey recruitment technique and completion mode, allowing the effects of survey recruitment and completion modes to be measured without confounding them

with sample frame, survey presentation effects or each other. Seven potential sources of bias are investigated: sample frame bias, response rate, item non-response, dropout rate, response differentiation, social desirability bias, and level of concentration.

4.2 Literature review

Modes of survey collection differ in several ways, including the method of recruiting potential respondents (door to door, postal, website, email), the medium of delivering the questions to respondents (in person, by telephone, post, internet), the means of recording answers (either by an interviewer or the respondent), and the means of following up with respondents who have not completed the survey task (Bowling, 2005). Each of these factors has a potential influence on responses, and thus introduces differing sources of bias to results. A growing field of research has attempted to tackle the implications of the growth in technologically assisted survey methods in terms of their impact on these different potential sources of bias. This literature review is split into two parts: an overview of the potential sources of survey bias investigated in this study and a brief overview of stated choice and willingness to pay research which has investigated survey bias.

Coverage error

Coverage error occurs when the sampled population differs significantly from the target population, which is the population of interest for research purposes, in terms of key socio-demographics. In many ways, coverage error is the single most important source of survey error for researchers, as large coverage error indicates that results from a survey are not representative of the target population and thus cannot be generalised. There are two main sources of coverage error: sample frame bias, when those contacted for participation do not accurately represent the target population, and low response rates, as this increases the likelihood that respondents differ significantly from non-respondents.

Sample frame biases occur when the target population differs significantly from the sample frame, which is defined as the set of respondents who can potentially be sampled in a survey (e.g. are in an area identified for door knocking, have a registered postal address for postal surveys, or a known email address for emailed surveys). Sample frame biases can be a considerable source of error in surveys, and must be closely scrutinised when determining whether the results of a survey can be generalised to the target population. For example, surveys which use non-random recruitment techniques, such as recruitment through social networks, may recruit only a subset of the overall population and may miss other segments of the population.

Internet and email distributed surveys have the potential to produce sample frame biases for two related reasons: internet uptake may not be universal across the target population and the distribution methods employed by the researchers may not reach all those who do have internet access. The level of sample frame bias introduced as a result of electronic survey distribution is highly dependent on internet access within the geographic area of interest (Couper, 2000; Schonlau, Soest, Kapteyn, & Couper, 2009). Lack of universal internet access remains a source of sample frame bias for internet distributed surveys, even among high income OECD countries, where on average 72% of household had access to the internet in 2012, the latest year with data available (OECD, 2013). Internet distributed surveys may particularly under-represent lower socioeconomic groups.

The other main source of coverage error is low response rates. The lower the response rate for a survey, the higher the risk that respondents may differ from non-respondents in their characteristics. This limits the ability of survey results to be generalised to the overall target population. Response rates are influenced by three main factors: contacted respondents' (un)willingness to participate, the researcher's inability to contact respondents (e.g. people who are out or who live in gated communities, and communication barriers (e.g. language or cultural barriers, sensory impairments) (Bowling, 2005). Each of these factors may be influenced by survey mode (e.g. some potential respondents may dislike being interrupted at home; people who have difficulty writing may be unable to respond to postal surveys). Traditionally, face to face interviews, with respondents contacted in person, have been considered to have the highest response rate of any survey mode. However, response rates across all survey modes have been generally declining over the past two decades, creating a substantial challenge for researchers who aim to achieve response rates that are as high as possible (Anseel, Lievens, Schollaert, & Choragwicka, 2010; Bowling, 2005)

Shih & Fan (2008) conducted a meta-analysis of thirty-nine published studies that directly compared web and postal survey modes, and found that postal surveys tend to have higher response rates than web surveys, with web surveys having response rates that are 10 percentage points lower on average. However, the study also found that responsiveness to survey mode is dependent on the type of respondent, with younger respondents preferring web surveys and other groups, such as medical doctors, school teachers, and general consumers, generally preferring traditional postal surveys. While postal and door to door surveys are generally considered to introduce the least coverage bias, this may not be the case with younger respondents, and the difference in response rates between web and postal/door to door surveys may decrease as an

increasing proportion of the population uses the internet. Manfreda et al (2008) conducted a meta-analysis of 45 published and unpublished studies that compared web and other survey modes, including mail, fax and telephone distributed surveys. On average, web surveys had an 11% lower response rate as compared to other traditional modes.

Item non-response

Item non-response occurs when a respondent either chooses not to complete a survey question, accidentally skips a question, or incorrectly completes a survey question and the response is unusable (e.g. checks two boxes instead of one). Item non-responses can be a concerning source of survey bias, especially in surveys which place a high cognitive load on respondents or in surveys that deal with highly sensitive questions. It is well known that survey mode can have a strong impact on the rate of non-response: the presence of an interviewer increases non-response to sensitive questions but can also ensure that respondents complete the survey correctly (Riphahn & Serfling, 2005). Item non-response, usually in the form of ‘don’t know’ or ‘refusal’ responses, is known to be influenced by survey mode and is frequently used as an indicator of response quality in surveys. Technologically assisted surveys have the potential to mitigate this source of error more than any other by allowing respondents to complete surveys privately while also ensuring that surveys are filled out correctly, as electronic surveys can keep track of responses and force answers before a respondent can proceed to the next question (Caeyers, Chalmers, & De Weerd, 2012; Denscombe, 2009). However, several studies have suggested that web surveys have higher rates of item-non response than face to face and telephone interviews (Bowyer & Rogowski, 2015; Heerwegh, 2009).

Dropout rate

A dropout rate for a survey is a measure of the percentage of respondents who do not fully complete the required survey questions. Higher dropout rates can reduce the total response rate for a survey. High dropout rates can be used as an indicator of respondents’ dissatisfaction with the survey experience, and dropout rates can be especially high for surveys that are very long, that are poorly worded or designed, or that place a high cognitive load on respondents. The ability to force answers in electronic surveys also has the potential to influence dropout rates, with participants failing to complete surveys if they are forced to complete questions they do not want to answer. However, some studies have suggested that forcing answers does not significantly increase dropout rates (Tourangeau, Conrad, & Couper, 2013). Dropout rates can be a significant contributor to overall response rates in web surveys; the average breakoff rate was found to be

6.6% in one meta-analysis of online panel surveys, but reported breakoff rates have been as high as 70% in some studies (Mavletova & Couper, 2015). Vicente & Reis (2010) found that questionnaire length, the display of survey progress to respondents, and the visual presentation style all had a significant impact on dropout rate. Lambert & Miller (2015) investigated the influence of completion device on dropout rates for a self-administered online survey. Those using a smartphone to complete the survey had a significantly higher dropout rate than those using a personal computer, while those using a tablet computer to complete the survey had a slightly higher dropout rate than those using a personal computer. Bosnjak & Tuten (2001) found that dropout rates were lower when demographic information was collected at the beginning of a survey rather than at the end, and that dropout rates were influenced by question type and formatting. Vicente & Reis (2010) found that the questionnaire length, the display of survey progress to respondents, and the visual presentation style all had a significant impact on dropout rate.

Measurement error

Measurement error refers to the means by which survey design and presentation influence survey responses, thereby producing responses which are different from a respondent's true opinions or circumstances. For example, telephone delivered surveys can experience a last option bias where the last choice is most recently heard, easiest to mentally recall, and thus disproportionately chosen (Bound, Brown, & Mathiowetz, 2001). Common sources of measurement error include confirmation bias and satisficing.

Social desirability, or confirmation bias has been shown to be much more common in interviewer than in self-administered surveys (Heerwegh, 2009; Kreuter, Presser, & Tourangeau, 2008; Lindhjem & Navrud, 2011). Social desirability biases are more likely in surveys that concern undesirable behaviours (e.g. smoking) or socially contentious attitudes (e.g. political opinions), and are more likely when questions are leading (Kreuter et al., 2008; Krumpal, 2011). Most studies investigating social desirability bias have compared electronic modes with traditional survey modes, and relatively few have compared social desirability biases between electronic survey modes. Mavletova & Couper (2013) investigated the influence of electronic survey completion mode, computer assisted self-interview or smartphone assisted self-interview, on social desirability bias. Respondents completing surveys on a smartphone were less likely to report alcohol consumption as compared to respondents completing surveys on a personal computer, but were equally likely to report other undesirable behaviours. Richens et al. (2010) randomised respondents to three survey modes: computer-assisted self-interview using a tablet, computer-assisted personal interview using a tablet, and pen and paper personal interview, in the context of a sexual health

questionnaire. Respondents using both computer-assisted modes were significantly more likely to disclose undesirable behaviours as compared to the pen and paper personal interview group, while responses for the computer-assisted self-interview group and computer-assisted personal interview group did not differ significantly. Kreuter et al. (2008) examined mode effect on social desirability bias by randomising respondents to one of three electronically assisted survey modes and validating responses against existing data. Computer assisted self-interview increased the level of reporting of sensitive information and reporting accuracy, as compared to computer-assisted telephone interviews and interactive voice recognition interviews.

Satisficing refers to a cognitive process whereby respondents attempt to limit the cognitive effort needed to answer survey questions, thereby providing less than optimal responses. This can be a result of incomplete or biased information retrieval or no information retrieval at all (making up answers). Satisficing can take the form of a number of response strategies, such as “choosing the first response alternative that seems to constitute a reasonable answer, agreeing with an assertion made by a question, endorsing the status quo instead of endorsing social change, failing to differentiate among a set of diverse objects in ratings, saying ‘don’t know’ instead of reporting an opinion, and randomly choosing among the response alternatives offered” (Krosnick, 1991, p. 1). For more complex survey designs, it is of interest to researchers that respondents read questions thoroughly and devote the attention necessary in order to answer a survey accurately and completely, so attempts are often made by researchers to reduce satisficing behaviour by designing surveys that will be straightforward, comprehensible, and enjoyable to complete for respondents.

The internet as a location for completing surveys significantly reduces the level of control researchers have in determining the survey environment. Respondents may for example have many internet windows open at once and may complete a survey while simultaneously undertaking other activities; this may impact level of concentration while completing a survey. As such, it could potentially increase distractedness and thus increase satisficing behaviour. Electronic surveys do however allow for some information to be collected that sheds light on the survey environment: electronic surveys also allow for metadata to be easily collected, such as the time taken to complete a survey, time taken on each question, and whether respondents alter their answers before submitting them, thus allowing for more information to be collected about the survey completion process than is possible for traditional pen and paper surveys. While satisficing can be difficult or impossible to measure directly, several indirect indicators of satisficing and measurement error have been developed by researchers. These include: frequency of ‘don’t know’ answers, length of open answers, frequency of answering sensitive questions, differentiation for Likert scale

questions, rounding numeric answers to round numbers, and response times (Lugtig & Toepoel, 2016; Zhang & Conrad, 2014).

When respondents are asked to answer several questions using the same rating scale, they may use satisficing techniques to reduce cognitive effort, such as tending to give the same answer for several questions or using few of the available response alternatives (Krosnick, 1991). McCarty & Shrum (2000) propose a differentiation index, which scores the number of different scale points used by a respondent. Uniform ranking, also referred to as straightlining, of responses across many questions can be viewed as a metric of satisficing, whereas differentiated (more negative/positive responses) and variable responses from one individual across several Likert questions indicates a higher level of concentration (Heerwegh, 2009; Krosnick, 1991). Straightlining has been identified as a source of concern in web surveys, and has been shown to be more common for respondents with lower education levels and who have fast response times (Cole, McCormick, & Gonyea, 2012; Zhang & Conrad, 2014). Survey completion times are also used as an indicator of satisficing and response quality, as longer survey times increase dropout rates, whereas very short completion times are associated with satisficing strategies such as straightlining and primacy effects (Couper & Kreuter, 2013; Malhotra, 2008; Zhang & Conrad, 2014). ‘Speeding’ survey responses have been described as response times that are unreasonably fast and result in arbitrary responses or extreme satisficing (Zhang & Conrad, 2014).

Examining satisficing in electronic survey modes, several studies have investigated the consequences of completing surveys on smartphones. For example, Wells, Bailey, & Link (2014) found that respondents completing surveys on smartphones give significantly shorter answers to open ended questions and have significantly longer completion times as compared to respondents using personal computers and tablets. In a review of 26 studies, smartphone users had longer completion times than personal computer users and tablet computer users had completion times that were equivalent or slightly longer than personal computer users and shorter than smartphone users (Couper & Peterson, 2016). Ha, Zhang, & Jiang (2016) compared response quality between computer-assisted self-interview and computer-assisted personal-interview modes, with both modes using a door to door recruitment mode. Computer-assisted self-interview had lower item non-response, higher completion of open answer questions, lower social desirability bias, but had lower levels of response differentiation in matrix questions. Lugtig & Toepoel (2016) examined the role of completion device on straightlining, and found that personal computer respondents straightlined more often than tablet and phone respondents, but performed better using other metrics of measurement error.

Stated choice and willingness to pay research

Two studies were found that compare internet and postal survey modes in the context of stated choice and willingness to pay research. Olsen (2009) compared two samples of respondents, one which completed a postal pen and paper questionnaire and one which completed an internet questionnaire, in the context of a stated choice study concerning landscape conservation. While the two groups varied in terms of socio-demographics, the two groups did not differ significantly in terms of estimated willingness to pay for landscape conservation, leaving the author to conclude that both completion modes are equally valid in conducting stated choice surveys where the object is obtaining willingness to pay figures for non-market goods. As the two survey samples had both different recruitment and completion modes, it is difficult to determine which was responsible for the socio-demographic differences between the two groups of respondents. Fleming & Bowden (2009) compared internet and postal samples in a stated choice survey concerning travel preferences in Australia. The study found that response rates and the socio-demographic make-up of respondents in the two groups were not statistically different from one another. Both survey modes yielded similar results, with the authors concluding that internet surveys are appropriate for studies of non-market valuation of travel costs.

Two studies were found that compare internet and traditional face to face survey modes. Marta-Pedroso, Freitas, & Domingos (2007) contrasted two sample groups, one recruited and completed via the internet and one recruited and completed via street intercepts, in the context of a contingent valuation survey¹⁰. The street-intercept recruitment method achieved much higher response rates than the internet method, but the two sample groups produced very similar results with regard to willingness to pay values. Lindhjem & Navrud (2011) compared an internet completion mode to a face to face completion mode in a stated preference study where participants were randomly assigned to one of the two survey completion modes. Face to face respondents were read the questions. Both groups were initially contacted via email, and were members of the same survey panel, thus isolating survey mode effects from recruitment mode and sample composition effects. Little evidence of social desirability bias was found in the face to face sample and mean willingness to pay responses for the two groups were within 30% of each other, with the authors concluding that internet surveys are not significantly different from face to face, and are appropriate for willingness to pay research attempting to quantify the value of non-market goods.

¹⁰ The term contingent valuation is used when the subject is the valuation of non-market goods, such as environmental amenities.

Two studies were found that compare different types of electronically assisted survey modes. Bronner & Kuijlen (2007) investigated the differences between three technologically assisted survey collection modes: computer assisted self-interview, computer assisted personal interview, and computer assisted telephone interview, in the context of a market research survey. The study found that computer assisted self-interview respondents gave less extreme answers and were more likely to report socially undesirable behaviours. The groups varied in terms of socio-demographics (such as age, income, and sex), and responses were weighted prior to analysis. Morrison, Hatton McDonald, Boyle, Rose, & Duncan (2013) investigated the difference between internet and mail recruited and completed surveys in the context of a stated choice survey concerning the valuation of environmental amenities. The study contained three sample groups: an email recruited and internet completed sample, an email recruited and postal completed sample, and a postal recruited and completed sample; this design enabled the study to separate completion mode effects from recruitment mode effects. The internet recruited samples had an approximately 30% lower response rate than the mail recruited sample and the two recruitment groups varied slightly in terms of socio-demographic composition. The two internet recruited groups also produced willingness to pay values that were about one third lower than those from the mail recruited panel, with the authors concluding that recruitment mode rather than completion mode was more influential on response rate and results.

4.3 Survey design

The current study examines potential sources of bias in a stated choice study regarding housing and neighbourhood preferences in Wellington, New Zealand. The target population was Wellington City residents over the age of 18. The experiment was designed to test three variables - recruitment mode effects, sample frame effects, and completion mode effects. As these effects are usually confounded with one another when comparing survey modes, this research makes a contribution to the literature by allowing their effects to be tested individually. In order to do this, the survey design consisted of two survey recruitment samples. One was contacted via email, with email contacts obtained from an email list maintained by the City Council of current city residents. These respondents were invited to complete the survey by following a link to an internet browser-based questionnaire.

The second sample group was invited to participate via a door to door recruitment method, utilising clustered stratified random sampling. As the subject of the study was preferences for housing and neighbourhood types, a stratified and clustered random sampling approach was used in order to ensure that the sample contained representation from individuals living across all

neighbourhood and housing types in the City. Four strata were created for housing density of neighbourhoods: very low density (0-34 persons per hectare), low density (35-50 persons per hectare), medium density (51-100 persons per hectare), and high density (100+ persons per hectare). After these strata were identified, a clustered approach was used to identify households, both in order to increase efficiency of data collection and to ensure that coverage was distributed evenly across the geographical area of the City. To this effect, 11 neighbourhoods were selected: 4 very low density neighbourhoods, 3 low density neighbourhoods, 2 medium density, and 2 high density neighbourhoods. In 2013, 45% of residents lived in very low density neighbourhoods, 25% lived in low density neighbourhoods, 18% lived in medium density neighbourhoods, and 12% lived in high density neighbourhoods (Statistics New Zealand, 2013). The number of Wellington residents living in a high density neighbourhood would imply a need for only one high density sampling area. However, two high density neighbourhoods were chosen in order to minimise the probability that the chosen neighbourhood was not representative of residents living in high density neighbourhoods. Wellington City consists of 5 geographical wards; to provide approximately even coverage of the geographical wards neighbourhoods were evenly distributed across wards. Neighbourhoods were defined as a contiguous area with at least 1,000 residents within a given density range. Neighbourhoods were also chosen so that the population of the selected neighbourhoods approximated the median income and household size of the city as of the 2013 NZ census.

Within each identified survey area, every fourth household was identified for participation, with four attempts made to contact each household. One adult household member was identified for participation based on nearest birthday. Each door to door respondent was given their choice of completion mode – in person using a tablet computer in the presence of the interviewer or online by following a link to the an internet browser based survey. Both the tablet computer and online surveys used the same internet browser based survey. Respondents were allowed the choice of survey completion mode in order to increase response rates and to be able to separate completion mode effects from sample frame effects. Two attempts at contact were made for both email groups, consisting of an initial invitation to complete the survey and a reminder email one week later if they had not completed the survey by that time.

4.4 Results

Coverage error

Since the advent of internet and email distributed surveys, coverage issues have limited the reliability of these survey modes. This is because internet and email use have been far from universal; thus these modes have introduced sample frame errors in all surveys except ones where internet use among the target population is universal, such as university students and online shoppers (Couper, 2000; Couper, Kapteyn, Schonlau, & Winter, 2007). A central question then becomes: is internet use in New Zealand widespread enough to warrant the use of internet distributed surveys without significant concerns of sample frame error due to low internet uptake?

The OECD estimates that New Zealand has the 15th highest household internet access in the OECD, with internet access that is slightly higher than the OECD average (OECD, 2013). The New Zealand census found that 76.8% of households had access to the internet in 2013. While this may seem low, it is important to note that internet access is rapidly expanding in New Zealand, growing by 16 percentage points between 2006 and 2013, an average of 2.3 percentage points per year (Statistics New Zealand, 2013). Extrapolating to 2015, it is probable that internet access had expanded to around 81% of the population. Despite the rapid expansion of internet access, there remains a digital divide in New Zealand. Those over 65, lower income individuals, and Maori and Pacific individuals are less likely to have access to the internet as compared to the overall population. 66% of those over 65, 68% of Maori, and 65% of Pacific individuals had access to the internet in 2012 (Statistics New Zealand, 2012). Income is the strongest predictor of internet access. In 2013, 46% of households with an income of less than \$20,000 per year had access to the internet whereas 96% of households with an income over \$100,000 had access to the internet (Statistics New Zealand, 2013). Despite these disparities, lack of internet access is less likely to be a source of bias in surveys in Wellington City; 87% of households in Wellington had access to the internet in 2013, roughly 10% percentage points higher than in New Zealand as a whole.

While incomplete internet uptake may currently be a source of sample bias for internet distributed surveys, and may especially result in under-sampling of the elderly, Maori and Pacific individuals, and those with low incomes, with the current rate of increase of internet usage it is reasonable to expect that this source of bias will eventually disappear or become so minimal as to be insignificant in a New Zealand context.

The second source of sample frame bias occurs when those contacted for participation via the internet or email are not representative of the subset of the population that uses the internet. This

source of bias seems likely to be an enduring component of internet distributed surveys and may even increase as internet participation increases. The more often people are contacted via email and the internet, the more likely they are to decline to participate in any one survey. Being over-contacted may also induce internet and email users to devise methods to minimise their ability to be contacted via email and the internet, such as routing emails to spam folders and using multiple email accounts. In this regard, researchers may face a choice between minimising sample frame bias and minimising response rate and cognition biases. Curated research panels, where organisations maintain lists of willing survey participants, can have high sample frame bias, as they tend to represent wealthier and more highly educated individuals, whereas wider email panels may have a smaller sample frame bias at the price of a lower response rate and respondents who are less experienced at filling out surveys.

For the door to door recruited group, a total of 523 individuals were contacted and 203 complete usable responses were received, for a total response rate of 38.8%. Of these responses, 48% were completed online. Five participants agreed to complete the survey but were unable to do so (four because of language barriers and one because of sensory impairment (blindness)). It is interesting to note that response rates varied widely across neighbourhoods, ranging from a high of 65% to a low of 23%. This variation showed no correlation with either neighbourhood density or income. For the group recruited via a Wellington City Council panel, 839 individuals were contacted via email and 251 completed usable responses were received, for a total response rate of 29.9%. Four surveys were completed but had to be removed from the sample as they were ineligible to participate (were not over age 18 or did not live in Wellington City). The email recruited group had a response rate that was 8.5 percentage points lower than the door to door recruited group, $\chi^2 = 10.54$, $df = 1$, $p < .001$, a slightly smaller difference than cited by Shih & Fan (2008) and Manfreda et al. (2008). The combined face to face and email recruited samples yielded a combined/overall response rate for the study of 33.3%.

Table 4.1 provides a comparison of the socio-economic and neighbourhood characteristics of the three sample groups to the Wellington City population as of the 2013 census. The email recruited group had a higher proportion of female respondents as compared to the door to door recruited group, $\chi^2 = 6.38$, $df = 1$, $p = .012$. Although it did not reach significance at the 95% confidence level, the door to door recruitment method was more successful at recruiting elderly respondents than the email recruitment method. While the two sample groups were not statistically different from each other with regard to income, it is worth noting that both survey groups under-

represented those in the lowest income group (\$20,000 or less) by about 50% as compared to the NZ census and over-represented those in the highest income group (\$100,001 or above).

The one measure on which the two recruitment groups did differ significantly was in regard to neighbourhood density. This can be attributed to two factors. Firstly, non-response on residential location was high among the email recruitment group (13.2%) and it is unknown if non-response was more likely for people living in some neighbourhoods as opposed to others. A second explanatory factor for the differences between the two groups is that the door to door list deliberately over represented residents in high density areas in order to achieve a sufficient number of respondents in this small population subgroup. When those who did not state residential

Table 4.1: Comparison of socio-economic and neighbourhood variables

Variables	Wellington - 2013 Census (n=251)	Email (n=251)	D2D - Tablet (n=117)	D2D - Internet (n=84)	D2D - All (n=201)	<i>p</i> D2D Tablet vs. D2D Internet	<i>p</i> Email vs. D2D All	<i>p</i> Email vs. D2D Internet
Gender						0.118	0.012	0.384
Male	48.4	40.2	55.6	45.2	51.8			
Female	51.6	59.8	42.7	54.8	48.3			
Age						0.165	0.102	0.602
18-24	18.0	11.6	15.4	10.7	13.4			
25-34	21.1	23.5	24.8	25.0	24.9			
35-49	28.4	42.6	24.8	38.1	30.3			
50-59	14.9	12.4	17.9	11.9	15.4			
60-69	9.7	7.2	11.1	13.1	11.9			
70-84	6.4	2.8	5.1	1.2	3.5			
85+	1.4	0.0	0.9	0.0	0.5			
Income						0.373	0.892	0.909
0-\$20,000	30.5	15.9	17.9	10.7	14.9			
\$20,001-\$30,000	9.3	8.0	6.0	7.1	6.5			
\$30,001-\$40,000	8.8	6.8	5.1	8.3	6.5			
\$40,001-\$50,000	8.3	8.0	12.0	10.7	11.4			
\$50,001 to \$70,000	13.3	19.1	20.5	19.0	20.0			
\$70,001-\$100,000	10.8	18.7	12.8	25.0	17.9			
\$100,001+	12.1	21.5	19.7	17.9	18.9			
Not Stated	6.9	2.0	6.0	1.2	4.0			
Neighbourhood Density						0.562	<0.001	<0.001
Very Low (0-35 pp/hectare)	45.1	36.3	28.2	25.0	26.9			
Low (35-50 pp/hectare)	24.7	27.1	19.7	19.0	19.4			
Medium (50-100 pp/hectare)	17.6	11.6	29.1	38.1	32.8			
High (100+pp/hectare)	12.5	12.0	23.1	17.9	20.9			
Not Stated	0.0	13.1	0.0	0.0	0.0			

location are removed from the sample, the email recruitment group provided a surprisingly close approximation to the distribution of residents across neighbourhood densities. This result provides support to the notion that online recruitment can be effectively used when the geographic distribution of respondents (e.g. across neighbourhoods of different density) is a matter of interest, although outcomes may vary depending on the method of recruitment (email or internet).

Item non-response

The frequency of item non-response is discussed for the three factual questions that were made optional as they sought potentially sensitive personal information, as well as the battery of Likert scale questions that related to priorities when choosing where to live. The three factual questions were: neighbourhood of residence, personal income, and weekly housing costs (rent or ownership costs). The neighbourhood of residence question is the only question that was recorded differently between the two recruitment groups: for the email group it was self-recorded and optional whereas for the door to door group it was recorded by the interviewer. Unsurprisingly, the frequency of non-response to the residential location question was higher among the email recruited group, $\chi^2 = 28.51$, $df = 1$, $p < .001$ (Table 4.2). Differences in the frequency of disclosing housing costs and income were not significant, suggesting that these may not have been particularly sensitive question for respondents. The frequency of non-response to the personal income question for all groups was lower than in the New Zealand Census, a self-administered and legally required pen and paper survey. For the battery of Likert scale questions, the percent of respondents failing to respond to any of the questions was higher in the tablet completion group than in either of the internet completion groups. However, the difference in frequency of non-response between the door to door-tablet group and door to door-internet group was not statistically significant, $\chi^2 = 1.605$, $df = 1$, $p = .205$ (Table 4.2).

Table 4.2: Comparison of item non-response between samples

Question	% Non-response				Tablet vs. D2D Internet		Email vs. D2D - All		Email vs. D2D Internet	
	Email	D2D -	D2D -	D2D - All	Chi-square	p	Chi-square	p	Chi-square	p
	(n=251)	Tablet (n=117)	Internet (n=84)	(n=201)						
Income	2.0	6.0	2.0	4.0	2.938	0.086	1.579	0.209	0.230	0.632
Housing Costs	1.6	2.6	0.0	1.5	0.113	0.737	1.213	0.271	1.339	0.247
Location	13.1	0.0	0.0	0.0	-	-	28.508	<0.001	12.251	<0.001
Likert scale (to one or more)	0.0	0.4	0.1	0.3	1.605	0.205	7.593	0.006	2.997	0.083

Social desirability bias

Self-reported measures of pro-environmental attitudes and behaviours may be subject to social desirability bias (Sullman & Taylor, 2010). The current study was conducted through a university department of Environmental Studies, with this affiliation disclosed to participants prior to beginning the questionnaire. This could potentially result in increased social desirability bias with regard to environmental attitudes and behaviours. The questions identified as being most subject to a potential social desirability bias were current and preferred travel mode. Respondents may have been likely to state a pro-environmental travel mode and may have been unwilling to disclose that their current behaviour is dissonant with desired behaviour. To minimise possible social desirability bias, the travel preference question preceded a separate travel behaviour question and the two questions were separated by several unrelated questions. Nevertheless, responses may be subject to bias. It was hypothesized that the pro-environmental travel mode options would be more commonly chosen by respondents completing by tablet in the presence of an interviewer.

Two tests were performed to investigate the presence of social desirability bias. The first was to compare the frequency of stating a preference for public or active transport, as opposed to the car, across sample groups. The second was to compare the frequency of stating a preferred travel mode that was different from a respondent's actual primary travel mode, across the sample groups. No statistically significant differences were found (Table 4.3). It was found that completion mode did not appear to influence responses to travel mode questions, as responses were not significantly different between those completing on a tablet as compared to those completing online, within the door to door recruited sample (Table 4.3).

Table 4.3: Travel modes and preferences

	Email (n=251)	D2D -Tablet (n=117)	D2D -Internet (n=84)	D2D - All (n=201)	<i>p</i> D2D Tablet vs. D2D Internet	<i>p</i> Email vs. D2D - All	<i>p</i> Email vs. D2D Internet
Preferred Travel Mode					0.240	0.775	0.654
Walk/Cycle	63.3	60.7	69.0	64.2			
Public Transport	16.3	17.9	8.3	13.9			
Drive	20.3	21.4	22.6	21.9			
Preferred vs Actual Travel Mode							
Same	19.9	10.6	13.9	12.0	0.524	0.046	0.262

Dropout rate

In the current study, dropout rates were a concern due to survey length (approximately 15 minutes) and due to the relatively complex design, which required mental processing of visual images as well as six attributes across three options for each of 12 choice tasks task (Refer to Chapter 5 for more details). It was hypothesized that the two internet completion groups would have equally high dropout rates, while the door to door/tablet completion sample would have a lower dropout rate because an interviewer can assist by explaining difficult questions and is present to motivate the respondent to complete the survey. The dropout rate for the door to door/tablet sample was 0.8%, while the dropout rate for the door to door/internet sample was 11.6%, and the dropout rate for the email/internet sample was 5.6%. Within the door to door recruited sample, those completing online had a significantly higher ($\chi^2 = 4.102$, $df = 1$, $p = .043$) dropout rate as compared to those completing with a tablet computer. The difference in dropout rate between the two internet completion groups was not significant ($\chi^2 = 2.668$, $df = 1$, $p = .102$).

Another issue which is of concern but which may or may not be considered as part of the dropout rate is individuals who initially agree to participate via email when contacted in person, but who later failed to start taking the survey. These individuals were sent a link to the survey via email, with a follow up reminder one week later. Of this group, 57% started the survey and 52% completed the survey. If all of those who agreed to participate via the internet had completed the survey, the response rate for the door to door to recruitment group would have been 52.9% rather than 38.8%. This figure raises issues as to the suitability of a distribution method combining door to door recruitment and email questionnaire distribution. There are several possibilities as to why this gap arose. The first is that many of these respondents did not intend to complete the survey at all and only agreed to participate out of politeness. This would suggest that a random assignment of respondents to a survey mode would have produced more similar response rates across the survey completion groups than self-assignment did. However, it is also likely that many of the door to door recruited /internet completion respondents who did complete the survey would not have participated in-person due to family obligations or other time constraints, suggesting that providing an internet alternative to an in person interview may boost rather than diminish response rates. Other explanatory factors which may prevent completion of an internet response are peculiar to email as a survey recruitment method. These include emails bouncing because mailboxes are full, emails being routed to spam folders, and emails being 'lost in the pile'. These issues were a factor for both internet completion groups and are likely to be an enduring element of email as a method of survey recruitment and distribution.

Response differentiation

The current study uses two metrics of satisficing, response differentiation and completion times, to investigate the influence of survey recruitment and completion modes on satisficing. Respondents were asked to answer a battery of 16 Likert scale questions relating to the importance of housing and neighbourhood attributes when the respondent was choosing their current dwelling on a scale of 1 (not at all important) to 5 (extremely important). As the questions asked respondents to recall previously held priorities and preferences as opposed to current ones, the questions introduced a burden of recall which may have made satisficing more likely.

A response differentiation index, P_d , was calculated using the method described by Alwin & Krosnick (1991) and McCarty & Shrum (2000). The rate is an index of the number of Likert scale points used by a respondent. In the current study a score of 0.0 would correspond to use of only one Likert scale point and a score of 0.8 would correspond to equal use of all five Likert scale points. Although the difference was small, those recruited door to door and completing the survey using a tablet computer had a lower average differentiation rate (.676) than those recruited door to door and completing online (0.702) and those recruited via email and completing online (0.681) (Table 4.4). The extent to which differentiation is due to use of middle, left extreme or right extreme values may shed light on the influence of survey presentation or confirmation biases on satisficing behaviour (Heerwegh & Loosveldt, 2008). When comparing among those recruited door to door, completion mode did not significantly impact the use of left extreme ($p=.93$), middle ($p=.89$), or right extreme (positive) ($p=0.51$) values. When comparing recruitment modes, those recruited door to door were less likely to use right extreme values ($p=.03$) and less likely to use middle values ($p=.02$) as compared to those recruited via email (Table 4.4).

Table 4.4: Likert scale ratings, controlling for neighbourhood density

Survey mode	Left Extreme	Middle	Right Extreme	P_d
D2D - Internet (n=84)	16.3%	25.1%	16.5%	0.702
D2D - Tablet (n=117)	17.0%	25.4%	15.9%	0.676
D2D - All (n=201)	16.7%	25.2%	16.1%	0.686
Email (n=251)	15.8%	22.0%	19.5%	0.681
p (Email vs. D2D-All)	0.28	0.02*	0.03*	0.46
p (Tablet vs. D2D-Internet)	0.93	0.89	0.51	0.08

Another means by which respondent concentration can be gauged is by the period of time taken to complete the survey. Very short times may indicate rush, whereas very long completion times could be an indication of either extreme care or distraction, depending on the circumstances. The average completion time for survey participants overall was 14.9 minutes (interquartile range: 12); for the email recruited group average response time was 13.1 minutes (interquartile range: 7), for the door to door- tablet completion group average response time was 28.5 minutes (interquartile range: 27), and for the door to door recruitment/internet completion group it was 23.0 minutes (interquartile range: 6). The researchers estimated that 10 minutes is the minimum period of time necessary to complete the questionnaire while reading all of the questions thoroughly, and that 45 minutes is the maximum time required for the slowest participant to complete the survey, with surveys under 10 minutes completion time representing rush and over 45 minutes representing distraction or completion in more than one sitting. For the two groups that completed the survey online, response times showed a similar pattern. 19% of respondents who completed the survey online completed it in less than 10 minutes, and 10% completed the survey in over 45 minutes. For the group that completed the survey in person with a tablet, response times were generally longer and had higher variance than in the email completion groups. 3% of respondents who completed the survey in person completed it in less than 10 minutes, and 8.5% completed the survey in over 45 minutes. Although the questionnaires displayed on a tablet and online (via the internet) were identical, one explanatory factor for the longer survey times on the tablet is that it took respondents some time to become accustomed to using a tablet computer. The distribution of survey completion times is similar for both groups completing the survey via the internet, while the average completion time varies considerably between these two groups (Figure 4.1). This difference is due to a larger percentage of respondents in the door-to-door internet group completing the survey in over 45 minutes, suggesting that the survey was completed in more than one sitting. The results indicate that the presence of an interviewer makes it more likely that respondents spend the necessary amount of time on a survey in order to thoroughly read the questions, but can also lead to unnecessarily long completion times in some circumstances (e.g. where the interviewer is drawn into discussion by the respondent).

Figure 4.1: Survey completion times by survey group

4.5 Qualitative elements

Aside from quantitative differences between survey recruitment and completion modes, it is worth noting that there are qualitative differences between the methods that may also impact data quality in quantitative surveys. Completing a survey in person allows for information to be exchanged beyond that which is included in a quantitative survey. Respondents can ask for clarification of questions; this happened during most face to face interviews conducted by the author, whereas only three email participants emailed the researcher with questions or comments. Information on the survey topic not included in the survey can also flow from the interviewee to the interviewer, enabling the researcher to gain an understanding of how questions are interpreted by respondents and judge whether the survey allows respondents to accurately respond. Here is an overview of information that was shared by respondents regarding the survey question design during face to face interviews:

- Four respondents mentioned proximity to medical facilities as important when choosing their residence and would have liked this to be included in the survey.

- Two respondents mentioned attachment to a family home as the sole reason for choosing a dwelling and said they ignored all other factors so that a dwelling could stay in the family.
- Three respondents mentioned that off street parking was unimportant when choosing where to live but presence of parking of some kind, whether it was private or on street, was important.

Overall, this relatively minor feedback, which was associated with the Likert scale questions, gives the researcher high confidence that the factors explored in the questionnaire provided a mutually exclusive and exhaustive list of considerations for nearly all respondents. A summary of feedback provided regarding the stated choice experiment, forming part of the questionnaire, is as follows:

- All but one tablet respondent was able to easily answer stated choice questions and said that the survey accurately represented their views. One participant objected to the design of the stated choice section of the survey and said she wished there was a 'would not move' choice.
- Six respondents stated that completing the stated choice experiment made them rethink their housing preferences. They said they realised that housing type and outdoor space were separate housing attributes, and realised which of the two was more important to them.
- Three respondents expressed concern about stairs in dwelling alternatives as they needed a wheelchair accessible dwelling.
- 20 respondents gave other insights into their choice process, unsolicited by the interviewer.

Face to face interviews allow researchers the opportunity to gain insight into both how respondents interpret survey questions and their overall survey experience. These insights can potentially help researchers improve future surveys and more accurately analyse their results, benefits that cannot be realised when utilising a remote completion mode. For surveys using a remote completion mode, pilot surveys that involve significant respondent feedback could help to overcome this limitation.

4.6 Limitations of the study and directions for future research

The most significant limitation of this study is relatively low sample sizes. The impact of survey recruitment and completion modes on data quality is potentially a serious concern for researchers and further research would be helpful to compare between digital modes to ensure recruitment is done by the most effective mode, especially as the technology available to researchers continues to evolve. It is worth noting that sample size issues are not independent of recruitment mode; door to door recruitment methods are time and labour intensive and thus often necessitate a limited sample size. Email and internet distributed surveys, in contrast, allow for many more participants at a much lower cost to researchers and over a much shorter time frame, often in as little as two to three weeks.

Another limitation is that among the door to door recruitment group, respondents were not randomly assigned to survey completion modes. This has the disadvantage that respondents self-selected to the completion mode of preference. This is mitigated however by the fact that the two surveys were identical, except in the face to face case where the interviewer provided a tablet for survey completion. As previously mentioned, the availability of these two completion choices was a deliberate means to increase participation and thus response rate. Future work could add to the literature by randomising survey completion mode.

4.7 Conclusion

Two changes to the surveying environment are likely to be of highest concern to researchers in the coming decades: continually declining response rates and the widespread use of electronically assisted survey completion modes. While these two issues are no doubt interrelated and interacting, the first represents a major challenge and the second represents a major opportunity. The challenge for researchers is at its heart, though, the same as it has been in years past, to create ‘good’ surveys – ones that participants want to do, that allow them to express their true opinions, and produce data that is valuable to the researchers.

While many studies have compared web surveys with traditional survey modes (Dillman et al., 2009; Heerwegh & Loosveldt, 2008; Holbrook, Green, & Krosnick, 2003; Rada & Domínguez, 2015), fewer have investigated the relative merits of different electronic survey modes while separating the impacts of survey recruitment and completion modes on responses (Kreuter et al., 2008; Mavletova & Couper, 2013; Richens et al., 2010). This study builds on and contributes to work in the area of survey mode and sources of error by providing additional insight into the relative merits of alternative modes of digital survey distribution and completion. This study has

added to the literature by investigating the relative merits of two survey recruitment methods: email and door to door, and two survey completion methods: internet self-completion and tablet self-completion in the interviewer's presence.

With regard to recruitment mode, a door to door recruitment method produced a higher response rate than an email list recruitment method. The two groups were roughly equivalent with regard to socio-economic characteristics. It is worth noting that this result is likely to be dependent on the character of the recruitment panel and survey distribution method used for email or online distributed surveys (Manfreda et al., 2008). The one measure on which the two recruitment groups did differ significantly was in regard to neighbourhood density. This can be attributed to two factors. Firstly, non-response on residential location was high among the email recruitment group (13.2%) and it is unknown whether this non-response was more likely for people living in some neighbourhoods as opposed to others. A second explanatory factor for the differences between the two groups is that the door to door list deliberately over represented residents in high density areas in order to achieve a sufficient number of respondents in this small population subgroup. Omitting those who did not state residential location, the email recruitment group provided a surprisingly close approximation to the Census distribution of residents across neighbourhood densities. This result provides support to the notion that online/email recruitment can be effectively used when the geographic distribution of respondents (e.g. across neighbourhoods of different density) is a matter of interest, although outcomes may vary depending on the exact electronic distribution method used.

With regard to completion mode, internet completion was contrasted with tablet self-completion in the presence of an interviewer. An in-person completion mode with tablet computer resulted in lower dropout rates, and longer completion times, but did not appear to influence social desirability bias. Tablet completion greatly reduced the likelihood of speeding through the questionnaire as well as completion in more than one sitting, but did not appear to reduce other metrics of satisficing, item non-response and straightlining. The current study found slightly higher differentiation for respondents completing online, a finding that is consistent with Rada & Domínguez (2015) and inconsistent with Heerwegh & Loosveldt (2008) and Bowyer & Rogowski (2015) who both found higher differentiation in traditional survey modes as compared to web surveys. While Rada & Domínguez (2015) speculated that higher differentiation in web surveys was due to survey presentation in colour, this was not the case in the current study as presentation was kept constant. Non-response for income was moderately higher for the in-person completion mode, while non-response for residential location was higher for the online completion mode (as

it was recorded by the interviewer for the in-person mode). The absence of evidence of social desirability bias suggests that the tablet self-interview may be an appropriate method of data collection for questions that may be prone to social desirability bias. It gives respondents more privacy than traditional pen and questionnaires and orally administered interviews, as responses once entered are immediately anonymised and are not able to be seen by interviewers. However, more research is needed in this area as the current study did not contain particularly sensitive questions.

Electronic survey methods offer many advantages to researchers, including decreased surveying costs which can allow for a greater number of respondents. The present study suggests that two key disadvantages frequently associated with electronic survey modes, lower response rates and higher sample frame biases, are associated with electronic survey recruitment rather than electronic survey completion. Door to door recruitment with tablet computer completion mitigated these sources of error, in addition to providing the benefits of a digital survey design, including decreased data processing costs, collection of paradata, and reduced social desirability bias.

CHAPTER 5

STATED CHOICE SURVEY RESULTS

5.1 Introduction

This chapter takes a demand side perspective and aims to identify preferences for housing and neighbourhood attributes among current residents of Wellington, New Zealand. It uses data from a stated choice survey of housing and neighbourhood attributes to examine individuals' preferences, and constructs a latent class multinomial logit model as a means of accounting for heterogeneity in preferences across the population. It investigates housing and neighbourhood preferences as they relate to urban form and transport, and the extent to which preferences can facilitate or hinder a transition to a more sustainable urban form. Furthermore, residents' preferences for housing and transport are contrasted with their current neighbourhood and transport types to investigate whether certain groups may be more able to realise their desired preferences than others in the current market. Understanding this relationship can inform the future potential of a transition to denser cities overall, as it can explain the motivations behind housing and neighbourhood choice and the circumstances under which individuals would willingly choose medium and high density housing.

5.2 Background

In light of concerns over the ability to accommodate population growth and achieve environmental outcomes, New Zealand's largest urban areas have in recent decades adopted residential intensification or 'compact' development as a guiding goal for planning, marking a juncture in the country's urban planning practice. However, this shift in planning practice has also met significant resistance and is frequently seen to be at odds with the preferences of residents. This is particularly the case among existing residents in low density neighbourhoods that have been targeted for intensification (The New Zealand Productivity Commission, 2015). The provision of compact housing is often seen as a politically contentious issue and to be at odds with other goals for housing in urban areas, such as housing affordability and housing amenity values (Carroll, Witten, & Kearns, 2011; Dixon & Dupuis, 2003). Therefore, successful provision of compact urban development depends in part on accurately gauging demand from the public. At the same time, there is very little understanding of what preferences and attitudes drive residential choice within the New Zealand context. Specifically, little is known regarding how and to what extent specific housing, neighbourhood, and transport related attributes contribute to residential choice. Revealed preference approaches may be ineffective, as housing and urban form in cities are to a greater or lesser extent the result of prescriptive planning rules and historical growth patterns (See Chapter 3 for further discussion). Gaining an in-depth understanding of how discrete attributes contribute to residential choice can inform the planning process by demonstrating what attributes

residents view as critical, shed light on the trade-offs that individuals make when choosing where to live, and potentially uncover a latent demand for a mix of attributes that may be unavailable or difficult to attain in the existing housing market.

5.3 Previous New Zealand research

A review of recent studies in New Zealand was conducted in order to determine the likely salient attributes when households choose dwelling types and neighbourhood densities and construct the stated choice experiment. Eleven studies were found which contribute materially to an understanding of current knowledge of preferences in New Zealand and the likely salient residential attributes in determining housing choice. Three of these studies were New Zealand wide, four were from Auckland, four were from Wellington, and one was from Wellington and Auckland.

A 2010 study investigated location and tenure choice decisions among 20-40 year olds in the Auckland region. Respondents were recruited from a list of recent movers and interviews were conducted via telephone; 499 responses were received for a response rate of 26 percent. The survey under-represented lower income households and over-represented higher income households. Respondents were asked reasons for choosing a house and preferred housing locations.

The study found that for this cohort, the most important dwelling characteristics for choosing where to live were:

- Home ownership, particularly for families
- A detached dwelling
- Dwelling comfort and functionality
- Dwelling safety, particularly for families.

The study also noted that many households struggled to achieve all, or even most, of those preferences. It found that home ownership and a detached dwelling were the most difficult characteristics to obtain, and noted that respondents had a deep suspicion and dislike of multi-unit developments, although it was often chosen as a housing type for reasons of affordability and destination accessibility (Saville-Smith & James, 2010).

A 2012 study conducted in-depth qualitative interviews with 84 residents living in medium density developments in Auckland City. Respondents were recruited from three case study medium density developments. The developments ranged in density from 57 to 67 residents per hectare and were within walking distance of town centres. The study found a strong preference for

standalone homes among those living in medium density housing. Over two-thirds of respondents stated a preference for living in a standalone house in the future, while 10% stated a preference for terraced housing, and only 6% a preference for a low-rise apartment (Haarhoff et al., 2012).

Allen (2015) examined how residents make trade-offs between low and higher density housing in Auckland. Qualitative interviews were conducted with 57 residents of medium density housing developments spread throughout the City. In contrast to Haarhoff (2012), when envisioning desired future residential locations, respondents were relatively evenly split between desiring low density and medium density housing. Accessibility to urban amenities was identified as the primary factor for choosing medium density housing. The primary factor in choosing low density housing in the future was not a preference towards low density, but rather other concerns such as build quality, lack of storage, kitchen space, the ability to have pets, and the ability to make renovations.

Yeoman & Akehurst (2015) examined preferences for dwelling type, dwelling size, and location in Auckland using a stated choice survey. Respondents were recruited via telephone and completed the survey via a web browser. 1,096 responses were received with a response rate of 13%. The survey over-represented higher income individuals, homeowners, and older individuals, and under-represented minority groups and one and two person households. Respondents were asked to choose between four alternatives which varied by the number of bedrooms, number of bathrooms, architectural style, layout, parking, land area, location, and price (Figure 5.1). Visual aids were provided for the layout, dwelling type, and location. A conditional logit model was constructed using four attributes: housing type, location, number of bedrooms, and price. Price was by far the most important variable, followed by dwelling location and then by dwelling type. Dwelling size, measured by number of bedrooms, was not statistically significant at the 15% confidence level. When making a trade-off between location, type, size, and price, just over half (52%) of all respondents chose a detached dwelling. This is in contrast to 75% of dwellings in Auckland currently being standalone dwellings. A significant limitation of the study is that there was a considerable number of variables in the choice task that were not held constant across the alternatives, including architectural style, parking, land area, layout, greenery, and dwelling colour. These variables likely influenced choices but were not incorporated into the modelling exercise.

Figure 5.1: Discrete choice experiment with visual aids

Source: Yeoman and Akehurst (2015)

A 2009 study by Wellington City Council examined the preferences and travel behaviours of inner city apartment dwellers in Wellington. Surveys were distributed to all central city apartment dwellers via a postal mailer. 1,350 responses were received, with a response rate of 25%. Fifty four percent of the survey respondents were female and the survey slightly over-represented higher income individuals. Respondents were asked the three most important reasons for them choosing to live in the central city and their desired future living locations.

The study found that the four most important reasons for choosing to live in the central city, ranking from most to least cited were:

- Lifestyle and ‘city living’
- To be close to work
- To be close to shops and cafes
- Low maintenance.

One of the limitations of the study is that the attributes were not well differentiated; ‘lifestyle and city living’ overlap heavily with the attributes ‘close to work’ and ‘close to shops and cafes’. The study found that inner city residents as a whole valued destination accessibility over indoor and outdoor space. However, a minority of respondents stated that they were not satisfied with their current residence; 18% of respondents said they were likely to move in the next 12 months due to apartment size and lack of indoor/outdoor space (Wellington City Council, 2009).

A study of Wellington residents investigated travel and neighbourhood preferences for residents of two neighbourhoods, Newtown, a medium density inner suburb with high destination accessibility and Churton Park, a low density outer suburb with low destination accessibility (Betanzo, 2012). Respondents were recruited via postal mailers; 267 responses were received with a response rate of 22%. Participants were asked to make seven one-way trade-offs between a compact and dispersed neighbourhood, assuming that price and other attributes were equal, with questions taken from Levine and Frank (2006). For example, respondents were asked: Would you prefer to live in a neighbourhood “that is a lively and active place, even if this means it has a mixture of single family houses, townhouses, and small apartment buildings that are close together on various sized lots” or a neighbourhood “with single family houses farther apart—on lots of 1000m² or more, even if this means that it is not an especially lively or active place” (Figure 5.2). 93% of residents from Newtown expressed a preference for the mixed use neighbourhood while 64% of residents from Churton Park expressed a preference for the mixed use neighbourhood. These results provide evidence of the desirability of mixed use, accessible neighbourhoods among

Wellington residents (even among residents of low density neighbourhoods), and suggest there may be an unmet demand for alternative transportation options and mixed use neighbourhoods in Wellington. While 80% of residents from Churton Park said that they typically commute via private motor vehicle, 4% said that they would prefer to use public or active transport. There are several drawbacks to this approach to gauging demand for compact development and alternatives to car travel. By assuming that the two hypothetical neighbourhoods are comparable in price and by presenting a relatively low density version of compact development, the survey may overstate the demand for this type of housing (Figure 5.2). Furthermore, the study is not very informative in providing insights into the conditions needed for households to choose compact development or the attributes that contribute to the valuation of compact and dispersed development types.

Witten et al. (2012) investigated levels of walking from active transport and leisure, controlling for self-selection, among residents living in more and less walkable neighbourhoods in Auckland, Wellington, and Christchurch cities. 12 neighbourhoods, stratified by walkability and demographics, were selected for each City, with a total of 497 respondents in Wellington. Preference for neighbourhoods was assessed using the Levine and Frank (2006) methodology. Among Wellington respondents, 86% of residents of more walkable neighbourhoods and 83% of residents of less walkable neighbourhoods expressed preference for the mixed use neighbourhood. This would seem to suggest that there is a significant unmet demand for walkability features among residents living in less walkable neighbourhoods.

A 2012 study of Auckland and Wellington residents examined the reasons for the increase of inner city populations in both cities (O'Fallon & Wallis, 2012). Respondents were recruited via an online panel which was intended to be representative of the New Zealand population. The survey received 785 responses, 85% of whom lived in suburban areas and 15% of whom lived in the inner city of the two cities, with a response rate of 24%. The study classified respondents into two residential preference groups, suburbanites and urbanites, according to responses to four questions: preference for inner city living as opposed to suburban living, preference for suburban living when traded off against distance to shops, schools and services, preference for walking, cycling, and public transport for commuting, and preference for driving for commuting (Figure 5.3). According to this classification mechanism, 13% of respondents were urbanites, 32% were suburbanites, and 55% did not clearly fit into either group. 43% of urbanites lived in the inner city whereas 93% of suburbanites lived in the suburbs, suggesting that it is much easier for suburbanites to realise their preferences in the housing market than it is for urbanites. When asked if they intended to live in a house with a section in the suburbs in the next 10 years, 54% of all respondents said they agreed/strongly agreed, 31% neither agreed nor disagreed, and 15% disagreed/strongly

Figure 5.2: One way trade-off

5. Your neighbourhood preference is:

0	1	2	3	4	5	6	7	8	9	10
strongly prefer A		somewhat prefer A			neutral			somewhat prefer B		strongly prefer B

A.

B.

If I were to move, I'd like to find a neighbourhood...

A. within 5-6 km of work, school, or my other important destinations, even if this means the houses are close together – on lots of 1000m² or less.

OR

B. with houses farther apart—on lots of 4000m² or more, even if this means travelling 25 to 30 kilometers to work, school or my other important destinations.

Source: Betanzo (2012)

disagreed. This is a notable result, as 85% of the respondents currently live in suburban areas. These survey results are notable in that they suggest that the majority of residents have conflicting preferences, preferring some aspects of compact development and some aspects of dispersed development.

A 2013 study examined the relationship of housing prices to residential attributes in the Wellington region using a revealed preference approach based on home values. The most significant predictors of home value, in order of importance, were: dwelling age, number of bedrooms, travel time to the CBD via public transit, distance to the CBD, and distance to public green space (Pettit, Daglish, de Roiste, Law, & Saglam, 2013). This study is notable in that it contrasts results from a revealed preference approach with the other stated preference surveys. It is the only study that included dwelling age as a factor, and found that this attribute had the largest impact on home values.

The New Zealand General Social Survey does not ask about housing and travel preferences, but rather asks about housing satisfaction and dissatisfaction - major problems with housing and neighbourhood. As such, it gives an indication of how well the current housing market is meeting people's needs and preferences and what specific needs and preferences are most often not met. It is important to note that the survey only asks about major problems, so other problems may be present which are not judged to be major by respondents. The extent of problems may be underestimated, as survey respondents tend to be optimistic about the condition of their housing as compared with objective evaluations (Buckett, Jones, & Marston, 2011). In 2010/11, 37% of New Zealanders reported having a major housing or neighbourhood problem and 40% of

Figure 5.3: Likert scale trade-offs

54 Indicate your agreement or disagreement with each of the following statements:

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
I prefer living in the inner city to living in a suburb.	1	2	3	4	5
I often use the telephone or the internet to avoid having to travel somewhere.	1	2	3	4	5
I'd rather live in a suburban neighbourhood, even if it meant I had to drive to shops, schools and services.	1	2	3	4	5
Being environmentally responsible is important to me as a person.	1	2	3	4	5
I'd rather live in a neighbourhood where I can walk to some shops, schools, and services.	1	2	3	4	5
In the next 10 years, I intend to live in a house with a section in the suburbs.	1	2	3	4	5
It's important to me to use environmentally-friendly travel methods (walking, cycling and public transport).	1	2	3	4	5

Source: O'Fallon and Wallis (2012)

Wellington region residents reported having a major housing or neighbourhood problem. It is interesting to note that Wellington had a higher rate of dissatisfaction than Christchurch, where the housing stock was severely damaged by earthquakes. Among Wellington respondents, 19% said their housing was too cold, 11% said their housing was too damp, and 13% said their housing was too small. The main neighbourhood related problem was noise. This is notable as the most common problems were not related to dwelling type, density, or transit accessibility but rather housing quality (Statistics New Zealand, 2013b).

Howden-Chapman, Hamer-Adams, Randal, Chapman, & Salmon, (2015) and Preval, Chapman, & Howden-Chapman (2010) conducted a survey of sentiments about urban form and housing preferences in a nationally representative online sample of New Zealand residents in 2009 (n=3,244) and 2015 (n=3,080). The two-part study examined trade-offs between dwelling size and destination accessibility rather than focusing on preferences for levels of housing density. A majority (67%) of respondents expressed a preference for mixed use development that located a home within walking or biking distance of common destinations such as shops. When asked their most preferred dwelling type, over 80% of the 2015 sample said they would prefer a standalone house. In 2009, when asked to make a trade-off between more residential space and a shorter commuting time, 26% said a shorter commuting time was more important than more residential space. In 2015, about 10 percent *more* respondents said that having a short commute was more important than residential space, suggesting that preferences for compact development may be increasing. These results suggest that New Zealanders want to have the benefits of both dense

(short commute time, proximity to destinations) and sprawling (larger houses, more land) neighbourhoods, but for most the latter interests outweigh the former. Interpreting responses to this question, however, is somewhat difficult as the question could be interpreted differently by different respondents. Trading residential space for a shorter commute could mean an apartment in the central city instead of a standalone house in an inner suburb or it could mean a small standalone house in an inner suburb instead of a large standalone house on the edge of the city.

A 2007 study of the residential preferences of New Zealand homeowners and renters was conducted in order to inform house designers and builders on future housing need in the coming years (BRANZ, 2007). 432 responses were received, with a response rate of 25%. 56% percent of respondents were occupants of newly constructed dwellings and 44% were residents of existing dwellings. The survey over-represented home owners and higher income households and under-represented renters and lower income households. Respondents were asked to rank the importance of nominated housing and neighbourhood features when choosing their current dwelling. The most important features, ranking from most to least important, were:

Dwelling features:

- Size of dwelling
- Double garage
- Detached house with garden/lawn
- Low maintenance walls/roof
- Quality of kitchen/bathroom fittings/fixtures

Neighbourhood features:

- Affordability of house and land
- Views
- Close to shops/cafes
- Suburban status
- Close to recreational facilities.

This study had several limitations which are related to its orientation towards homeowners rather than renters, and suburban rather than urban residences. The survey respondents contained a disproportionate number of homeowners and high income earners. The survey design included 'double garage' as the only possible parking option. As a result, it is likely that respondents who wanted parking would have selected this option, and it is therefore difficult to determine the proportion of people who had a preference for double garages as compared to other forms of parking. The variables for housing and outdoor space were combined into one attribute, 'detached

house with garden/lawn’, making it difficult to determining the relative importance of house type as compared to outdoor space.

To sum up, a range of studies has been conducted in New Zealand on the subject of housing and neighbourhood preferences, and has used a variety of recruitment strategies and methodological approaches to assessing preferences for housing and neighbourhood attributes. Affordability/price was found to be the most important variable in the choice of dwelling in two studies (BRANZ, 2007; Yeoman & Akehurst, 2015), dwelling size was the most important variable in two studies (BRANZ, 2007; Howden-Chapman et al., 2015), dwelling type (a standalone dwelling) was the most important variable in one study (Haarhoff et al, 2012), and dwelling age in another (Pettit et al., 2013) (Table 5.1). Three studies have indicated a preference for mixed use, accessible neighbourhoods, suggesting that there may be an unmet demand for this type of housing. Most studies have used ranking or an unbounded stated preference approach. Betanzo (2012) and Howden-Chapman et al. (2015) investigated trade-offs between two attributes (such as size and distance to centre) while Yeoman & Akehurst (2015) examined preferences among four attributes (type, location, number of bedrooms, and price).

While many of the studies have identified dwelling size as a key factor in the choice of housing and neighbourhood, there is a gap in the literature regarding what constitutes size in the minds of respondents – size could mean the number of bedrooms, dwelling area, dwelling type, size of outdoor space, and even availability of parking. Most of the studies conducted on housing preferences in New Zealand have not been representative and have under-represented lower income households, minority groups, and younger individuals. This is significant as housing and neighbourhood preferences are likely to vary by demographics. Response rates in past studies on

Table 5.1: Studies reviewed

Study	Location	Number of respondents	Response rate	Method	Most important dwelling attribute	Most important neighbourhood attribute
Saville-Smith & James (2010)	Auckland	499	26%	Attribute ranking	Tenure (ownership)	n/a
Haarhoff et al. (2012)	Auckland	84	n/a	Qualitative interviews	Standalone house	n/a
Allen (2015)	Auckland	57	n/a	Qualitative interviews	n/a	Destination accessibility
Yeoman & Akehurst (2015)	Auckland	1096	13%	Discrete choice (mnl model)	Price	Dwelling location
O’Fallon & Wallis (2012)	Auckland/Wellington	785	24%	One way trade-offs	n/a	n/a
Pettit et al. (2013)	Wellington	n/a	n/a	Revealed preference	Dwelling age	Travel time to CBD
Witten et al. (2012)	Wellington/Auckland/Christchurch	1806	45%	Conjoint trade-offs	n/a	n/a
Betanzo (2012)	Wellington	131	22%	Conjoint trade-offs	n/a	Proximity to amenity/work
Wellington City Council (2009)	Wellington	1350	25%	Attribute ranking	n/a	Lifestyle and 'city living'
NZ General Social Survey (2011)	New Zealand	n/a	n/a	Dwelling and neighbourhood problems	n/a	n/a
Howden-Chapman et al. (2015)	New Zealand	3080	n/a	One way trade-offs	Standalone house / more residential space	Mixed use/accessible
BRANZ (2007)	New Zealand	432	25%	Attribute ranking	Dwelling size	Affordability

this subject have ranged from 13 to 45%, with an average of 25.7% across seven studies. Almost all studies in New Zealand have found that there is a preference in principle for detached housing. However, destination accessibility is also strongly valued and many factors besides density, such as warmth and dryness, dwelling age, and price, are important in the housing choice decision.

5.4 Research method

The choice process for market and non-market goods differs in distinct ways across groups of people. Segmentation, or the separation of the market for goods into subgroups, has been widely used as a research and marketing tool in several fields, including marketing, transportation planning, economics, and environmental studies. Its benefits are clear: there is often little merit in researching or addressing the average consumer, as preferences are diverse and many may have opposing preferences. This can be problematic as opposing preferences can have the effect of negating each other. Although the objectives and benefits of segmentation are widely acknowledged, there is a variety of methods used, and the term segmentation therefore describes a variety of approaches. Segmentation methods can be separated into two types - *a priori*, where groups are selected prior to analysis based on one or several known characteristics, such as socio-demographics, location, frequency of car use (e.g. Bagley & Mokhtarian, 1999), and *post hoc*, where some type of statistical analysis is used to identify segments (e.g. Liao, Farber, & Ewing, 2015; Rid & Profeta, 2011). *Post hoc* segmentation offers two advantages over *a priori* segmentation. Firstly, while *a priori* segmentation may provide useful insights, it is subject to the categorisation of all of those in a group based on the preferences of the majority or the most coherent or stereotypical description (e.g. while most families may prefer standalone houses this is certainly not the case for all families). Secondly, with *post hoc* segmentation, the segments are determined by the data (beyond the choice of segmentation variables) rather than the researcher, and the number of preference groups and their relative sizes are not known until the process has been completed (Anable, 2005; Wedel & Kamakura, 2000).

Latent class analysis was developed by Lazarsfeld, Henry, & Anderson (1968) in the context of market research in order to more accurately describe consumer preferences, which were previously defined as either homogeneous or determined by external groupings (such as educational attainment, geographic location). Latent class (LC) analysis accounts for preference heterogeneity by identifying heterogeneous subgroups of the population with similar preferences according to their preferences, rather than by external variables. Several methods of *post hoc* segmentation have been used for different types of data and research questions, including multinomial logit modelling and latent class cluster analysis (Figure 5.4).

Figure 5.4: Segmentation and modelling families

Latent class logit models (LC MNL) use data from discrete choice experiments to identify preference groups and estimate their preferences for discrete attributes. Unlike other methods, it is not dependent upon a pre-defined specification of preferences or class groups. Instead, class membership and class profiles are determined by respondents' choices and/or behaviour, and may also include other individual level characteristics such as demographics and attitudinal variables (Greene & Hensher, 2003; Louviere, Hensher, & Swait, 2000). LC models may be based either upon data collected in a stated choice experiment or from observed real world behaviour. A stated choice experiment is the preferred method when the research subject is one that is not widespread in the current marketplace, as is the case with medium and high density housing in New Zealand.

LC MNL based on stated preference data offer three main advantages which make it ideal for this study. It allows researchers to separate and quantify preferences for individual housing attributes which are otherwise combined. It allows preference heterogeneity to be accounted for in a way that is cognitively relatively easy to process and thus communicable to policy makers. Choices can be used simultaneously with the socio-demographic characteristics of respondents in order to identify class membership in a one step process in order to understand how socio-demographics relate to housing and neighbourhood preferences.

Several studies have used a stated choice approach to estimate demand for, and preference heterogeneity in relation to, housing (e.g Hoshino, 2011; Liao et al., 2015; Olaru, Smith, & Taplin,

2011; Rid & Profeta, 2011; Walker & Li, 2007). For example, Olaru et al. (2011) used a latent class approach to estimate the latent demand for transit oriented development in a new rail corridor in Western Australia. Liao et al (2014) used a stated choice experiment and latent class modelling to estimate demand for compact, walkable neighbourhoods in Utah, United States, and also incorporated socio-demographics and attitudinal variables as factors for determining class membership.

5.5 Model formulation

LC MNL models are a type of multinomial logit model that allows for the identification of market segments as a means of accounting for the heterogeneity of preferences across the population, and are an extension of the conditional logit model developed by McFadden (1974) (Figure 5.4). Like other discrete choice experiments, discrete choice experiments using latent class models operate within the context of a random utility framework. Under random utility theory, the utility of a good comprises the sum of the utilities of its component parts, in addition to a random or unexplainable component. These component parts can be described as attributes, which in turn have various values, known as levels. For example, the size of a dwelling may have three levels (e.g. small, medium, large) in a particular model.

For each respondent i the utility of an alternative j is a function of the housing and neighbourhood attributes X_{ijt} in choice situation t is:

Equation 1
$$U_{ijt} = \beta_c x_{ijt} + \varepsilon_{ijt}$$

In a discrete choice experiment, respondents are asked to choose between two or more options where the options are composed of attributes with various finite levels. By repeating this task multiple times, various combinations of attribute levels can be displayed to the respondent. This method introduces dependence between observations, allowing the researcher to disentangle the relative impact of each attribute (and attribute level) on the overall utility of a good, resulting in part-worth utilities of attributes that describe their contribution to a good's utility (Kanninen, 2007; Louviere et al., 2000). Constructing a discrete choice experiment involves selecting the attributes which are the most salient to influencing choice behaviour and are to the greatest extent possible, mutually exclusive, exhaustive, and finite in number. However, these priorities must also be weighed against the cognitive burden placed on respondents; the complexity and length of the survey must be minimised in order to ensure participation and the elicitation of accurate responses (Kanninen, 2007).

The probability that a respondent i chooses alternative j from a choice-set J in choice situation t is:

Equation 2

$$P_{ijt|c} = \frac{\exp(\beta_c x_{ijt})}{\sum_{j=1}^J \exp(\beta_c x_{ijt})}$$

In a latent class logit model, it is assumed that respondents belong to different latent classes which are determined by their preferences towards the attributes in the choice experiment. Class membership is not assumed to be known and is instead treated as a probabilistic function which can be estimated using choices as well as observed attitudinal and socio-demographic variables (Walker & Li, 2007).

In the present study all estimation was conducted using Latent Gold Choice v. 5.0 (Vermunt & Magidson, 2005, 2013). This software uses a non-parametric variant of the mixed conditional logit model that uses latent classes to account for preference heterogeneity (Louviere et al., 2000; McFadden & Train, 2000; Vermunt, 2010). Class membership is determined using a function where class membership is assumed to be probabilistic and the number of classes is finite. The inclusion of attitudinal and socio-demographic variables can both increase the predictive power of the function and allow the researchers to estimate the probabilities of class membership of individuals who did not participate in the discrete choice experiment (Vermunt, 2010). In this study the covariates used were demographic variables (age, income, gender, household type, residential location) and attitudinal variables (commute mode preference, prioritisation of attributes when choosing the current dwelling).

5.6 Survey design

Residential preferences are known to be both complex and heterogeneous in nature; there are dozens of attributes embedded within the choice of housing (e.g. home age and style, nearby schools, nearby parks, parking, transport choices, kitchen and bathroom, heating/cooling/insulation), and it is known that preferences are far from homogeneous: individuals and households have disparate means of prioritising these many elements of housing when choosing where to live. This study, by necessity, takes a narrow view of housing preference in that it focuses on preferences as they relate to housing type and neighbourhood characteristics such as destination accessibility by transport mode, and density. Previous research has shown that preferences towards housing type, density and transport are both heterogeneous and correlated to socioeconomic characteristics, such as age, educational attainment, household type, and income. A well designed experiment investigating housing preferences must also take stock of the detailed,

interwoven relationship between housing preferences, travel preferences, and the willingness to pay for these attributes.

The number of attributes, attribute levels, and alternatives presented in a choice experiment influences the decision-making process for participants. While it is unlikely that there is an ideal stated choice design for any given subject given the wide variety of data processing strategies of respondents, the stated choice study design does influence the results of the study. While increasing complexity in stated choice experiments can increase the cognitive burden on respondents and decrease the attention paid to each attribute, the influence of survey complexity on the quality of survey responses is to some extent determined by the relevance of attributes rather than their number (Arentze, Borgers, Timmermans, & DelMistro, 2003; Hensher, 2006). While all attributes may not be fully considered by all respondents in stated choice surveys, the coping strategies that respondents use when faced with complex surveys are analogous to the approach to choices made in real world markets. With this in mind, it is the relevance of attributes to the choice at hand and the comprehension of the choice task by respondents that is critical (Hensher, 2006). The combination of separate attribute levels into one attribute, or conversely the separation of one attribute into separate attributes, also has an impact on the decision-making process. When ‘good’ attributes (positively valued) are separated into distinct attributes, they may appear more desirable to respondents and conversely, separating out a ‘bad’ component of an attribute into a distinct attribute can make it seem less desirable (Hensher, 2004). In the context of stated choice studies on housing and neighbourhood density, the combination of the attributes for dwelling type and outdoor space may make standalone dwellings with sections appear disproportionately attractive as compared to multi-unit dwellings with porches or no outdoor space. Another factor which influences choices is the variation among attribute levels. The more that attribute levels deviate from each other or from a reference alternative, the more likely attributes are to be considered during a choice task (Hensher, 2006). In the context of stated choice studies on housing and neighbourhood density, this would suggest that the widest variation in density-related attributes should be included to ensure that they are processed by respondents. However, much of the previous literature has used a relatively narrow density range that is relatively low density.

In the present study, attributes were chosen using three criteria: they had been previously identified in the literature as being important to the housing choice decision; they are related to density, land use, and transport; and they are under the control of local planning bodies and thus a subject of debate with regard to planning policy and to some extent controlled through the planning process.

The survey design had to include the effect on residential selection of:

Table 5.2: Attributes and levels used in the present study

Dwelling type	Destination accessibility	Neighbourhood density	Outdoor space	Parking	Price (market rent)
Apartment	5 min walk to local shops 5 min drive to CBD 15 min bus to CBD	Primarily standalone houses	None	None	Lower quartile
Townhouse	10 min walk to local shops 15 min drive to CBD 30 min bus to CBD	Mix of apartments/townhouses & standalone houses	Porch/balcony	On-street	Median
Standalone house	30 min walk to local shops 30 min drive to CBD 60 min bus to CBD	Primarily apartments/townhouses	Small section	Off-street	Upper quartile
			Large section		Upper quartile *1.2

- Neighbourhood attributes, specifically those which are recognised as being critical determinants of travel behaviour
- Housing attributes, including those which are strongly related to urban form
- The travel opportunities that are embedded in residential location choice

The final attributes chosen were: housing type, outdoor space, neighbourhood density, destination accessibility (time to destinations by driving/public transport/walking), and parking provision. Each of these attributes was given three to four levels, which were intended to cover the extent of variation within the City of Wellington (Table 5.2).

The dwelling type attribute was accompanied by a visual aid, as it became clear in the survey design process and during the pilot survey that housing types are not well understood in New Zealand and that verbal descriptions of housing types are not universally interpreted. The inclusion of a visual aid in a choice experiment can add an element of realism to the choice decision and also provide clarification for the respondent which is often not available with remote interview methods (Jansen, Boumeester, Coolen, Goetgeluk, & Molin, 2009; Orzechowski, Arentze, Borgers, & Timmermans, 2005; Vriens, Loosschilder, Rosbergen, & Wittink, 1998). However, inclusion of visual aids can also affect the decision-making process. Respondents who spend more time on the evaluation of a particular attribute may tend to value it more, and the inclusion of a visual aid for one attribute may lead to it being more strongly valued (Chen, Caputo, Nayga, Scarpa, & Fazli, 2015). Visual aids may or may not include extraneous information; the former may violate the *ceteris paribus* assumption that is necessary in a choice experiment. In the case of housing, respondents may make choice decisions based on extraneous details such as dwelling colour and surrounding greenery if this is evident in the visual aid (Jansen et al., 2009). In the current study the visual aids provided for the housing type variable were kept as similar to one another as possible; the housing image for each housing type indicated the same age and architectural style and they were presented as stylised black and white images to remove extraneous attributes (Figure 5.5).

Figure 5.5: Example of a choice question

	Apartment	Townhouse	Standalone house

Outdoor space	None	Large section	Small section
Destinations	5 min walk to local shops 5 min drive to CBD 15 min bus to CBD	10 min walk to local shops 15 minute drive to CBD 30 minute bus to CBD	30 min walk to local shops 30 min drive to CBD 60 min bus to CBD
Dwellings in Neighbourhood	Mix of apartments / townhouses and standalone houses	Primarily apartments / townhouses	Primarily standalone houses
Parking	On street	None (available for purchase)	Off street
Market rent	\$ 500 per week	\$ 500 per week	\$ 500 per week

Price was included to allow for the valuation of the other attributes and to mimic real world decision making processes. The first five attribute levels (Table 5.2) are nominal in nature. Price is numeric and was expressed in dollars to respondents, but was designed as a ratio in order to allow for comparability between respondents and to provide a temporally consistent figure.

Price was given four levels and expressed in terms of weekly housing costs, as determined by market rental prices published in 2013/2014 by the Ministry of Business, Innovation and Employment (MBIE). These rents were for the lower quartile, median, upper quartile, and 20% above the upper quartile for each number of bedrooms and rounded to the nearest \$50 increment. The highest rent was 20% above the upper quartile to ensure that it represents the highest typical rent for a dwelling in Wellington City.

In the current study, respondents were asked to choose between three different dwellings, which were labelled as a standalone house, a townhouse, or an apartment. Each respondent was asked to respond to 12 choice sets. The experiment design was created using the efficient design method (Rose & Bliemer, 2009) using the NGENE Software by ChoiceMetrics. Efficient design methods use previous knowledge about the values of attributes to design more efficient choice questions, and are thus able to decrease sample size requirements and/or increase the reliability of parameter estimates. Prior information about the values of attributes was obtained from a pilot distribution of the survey completed by 20 Victoria University employees and students, which used an orthogonal factorial design. For the main survey, the prior information was derived from analysis of pilot survey responses. The D-error criterion was used to determine choice tasks, as it is considered the most appropriate criterion when designing a stated choice experiment that will be used to model market segmentation (Kessels, Goos, & Vandebroek, 2006; Rose & Bliemer, 2009). There is not an agreed upon best practice for determining an efficient design to be used in a latent

class stated choice experiment. The basic fall-back method would be to create an efficient design method assuming the use of a simple MNL model. This was determined to be inadvisable in the current case, as pilot study results indicated that two groups had preferences that were opposing in sign from one another, i.e. they had essentially opposite preferences, with the result that they essentially negated each other. Due to this situation, another method was devised. Two efficient designs were created with priors from each preference group. These were then put together to create a blocked design, with two blocks consisting of half the questions from one design and half from the other. The first half of respondents received the first block and the second half of respondents received the second block of questions.

In addition to the stated choice component, the survey included questions about individual and household characteristics, a Likert scale rating of priorities when the respondent was choosing their existing dwelling, preferred travel mode, current travel behaviour, and satisfaction with house and neighbourhood (see Appendix B for full survey questionnaire). Ethics approval was obtained from the Victoria University of Wellington Human Ethics Committee and the survey was preceded by an information sheet (see Appendix A for ethics approval)

5.7 Survey distribution

The survey was intended to capture the wide range of residential preferences as they relate to housing and neighbourhoods among Wellington residents. As preferences are likely to vary by age, household type, income level, and current neighbourhood type, respondents had to be recruited from a range of neighbourhood types which reflected the diversity of incomes, age groups, and housing types in Wellington City.

The survey design consisted of two separate survey samples, one recruited door to door and the other recruited via email. This mixed mode survey recruitment approach was designed in order to test the relative merits of two technologically assisted survey techniques, a door to door recruitment with completion via tablet computer and email recruitment with completion on a web-based browser. This research into survey completion mode makes a contribution to the literature by holding the survey presentation constant while varying the survey recruitment mode and survey completion mode, allowing the effects of survey completion and recruitment modes to be measured without confounding them with sample frame and survey presentation effects (see Chapter 4 for more details).

One sample group was contacted via email and completed the survey by following a link to a web browser-based questionnaire, with email contacts obtained from an email list maintained by the City Council of current city residents. The second sample group was invited to participate via a

door to door recruitment method, utilising clustered stratified random sampling. As the subject of the study was preferences for housing and neighbourhood types, a stratified and clustered random sampling approach was used in order to ensure that the sample contained representation from individuals living in each neighbourhood density stratum in the city. Four strata were created for housing density of neighbourhoods: very low density (0-34 pp/ha), low density (35-50pp/ha), medium density (51-100 pp/ha), and high density (100+pp/ha). After these strata were identified, a clustered approach was used to identify households, both in order to increase efficiency of data collection and to ensure that coverage was distributed evenly across the geographical area of the city. To this effect, 11 neighbourhoods were selected: four very low density neighbourhoods, three low density neighbourhoods, two medium density, and two high density neighbourhoods (Figure 5.6). Wellington City consists of five geographical wards; to provide even coverage of the geographical wards of the city, survey neighbourhoods were selected to be evenly distributed across wards. Neighbourhoods were defined as a contiguous area with at least 1,000 residents within a given density range. Neighbourhoods were also chosen to approximately match the income and household types to the city average. Approximately 10% of Wellington residents live in a high density neighbourhood, which would, in principle, imply a need for only one high density sampling area. However, two high density neighbourhoods were chosen in order to minimise the probability that the chosen neighbourhood was not representative of residents living in high density neighbourhoods.

Within each identified survey area, every fourth dwelling was identified for participation, with four attempts made to contact each household. One adult household member was identified for participation based on nearest birthday, and was given the choice to participate either by completing the survey using a tablet computer in the presence of the interviewer or by following a link to the same web browser based survey used for the other sample group. Respondents were allowed the choice of survey completion mode in order to increase response rates and to be able to separate completion mode effects from sample frame effects. Two attempts at contact were made for both email groups, consisting of an initial invitation to complete the survey and a reminder email one week later if they had not completed the survey by that time.

Individuals aged 18 years and above and usually resident in dwellings in selected neighbourhoods were deemed eligible to participate in the study. Where there was more than one eligible person in the household, potential participants were identified by the criterion of having the nearest birthday. In the event that there was no eligible adult residing in the household or the eligible adult refused to participate, the household became 'closed' and the interviewer moved on to the next household identified. If no-one was at home or an eligible adult resided in the household, but was not

available, the interviewer made a maximum of three return visits for recruitment purposes. For each survey response, the survey area and dwelling type was recorded, but the address and name of the respondents were not recorded; i.e. the respondent remained anonymous.

5.8 Results

Survey response rate and demographics

In total, 454 completed responses were received, 203 of which were recruited in person and 251 of which were recruited online. The combined face-to-face and email recruited samples yielded a combined/overall response rate for the study of 33.3%. For the door-to-door recruited group, a total of 523 individuals were contacted and 203 complete usable responses were received, for a response rate of 38.8%. Of these responses, 48% were completed online. For the group recruited via a Wellington City Council panel, 839 emails were sent and 251 completed usable responses were received, for a response rate of 29.9%. The survey sample under-represents the lowest income bracket (0-\$20,000) and over-represents the highest income bracket (\$100,000 or more) (See Chapter 4 for more details). This is a problem common to many surveys as, even when income groups are evenly sampled, those with higher incomes are more likely to agree to participate in surveys. Other than this, the survey sample provided a good representation of Wellington City residents. The response rate was higher than many other recent surveys on the topic in New Zealand where these were reported.

Results

The responses from the stated choice experiment were used to construct a latent class multinomial logit model of housing and neighbourhood preferences among Wellington residents. Estimated utility function parameters are shown in Table 5.3 and class membership parameters (socio-demographic and attitudinal variables) are shown in Table 5.4. Table 5.3 shows both the results for a one class MNL model and a LC MNL model. Figure 5.7 represents the coefficients for the LC MNL visually. The results of the MNL model can be interpreted as basic findings before preference heterogeneity is taken into account. All of the coefficients in the utility function and all of the differences in coefficients across class groups are significant at the 1% level. Positive coefficient values indicate that an attribute level has a positive impact on utility, while negative coefficients indicate that an attribute level negatively impacts utility.

Figure 5.6: Responses by area

Table 5.3: Model outputs

	MNL Model		LC MNL Model			
	Overall		'high density preference'	'medium density preference'	'low density preference'	'very low density preference'
R^2	0.24		0.55	0.30	0.28	0.64
Class Size (proportion of sample)			0.28	0.24	0.26	0.21
Housing Attributes		p-value				p-value
<i>Dwelling Type</i>						
Apartment	-0.48	0.0	-0.31	-0.29	-0.52	-2.17
Townhouse	0.04		0.26	0.10	0.13	0.23
Standalone house	0.44		0.06	0.19	0.39	1.94
<i>Outdoor Space</i>						
None	-0.54	0.00	-0.50	-0.39	-1.20	-2.56
Porch / Balcony	0.07		0.06	-0.11	-0.06	0.01
Small section	0.23		0.52	0.30	0.53	1.10
Large section	0.25		-0.09	0.20	0.73	1.44
<i>Destination Accessibility</i>						
High	0.71	0.00	1.75	0.43	0.95	0.20
Medium	0.35		0.91	0.11	0.53	0.27
Low	-1.05		-2.66	-0.53	-1.48	-0.48
<i>Neighbourhood Density</i>		0.00				
High	-0.10		0.08	-0.04	0.05	0.15
Medium	-0.01		0.22	-0.09	0.22	-0.40
Low	0.11		-0.30	0.13	-0.26	0.25
<i>Parking</i>		0.00				
None	-0.37		-0.50	-0.59	-0.36	-0.24
On-street	0.05		0.14	0.05	0.16	0.07
Off-Street	0.33		0.36	0.54	0.20	0.17
<i>Price</i>	-0.01	0.00	-0.0121	-0.0097	-0.0008	-0.0058
						0.00

Figure 5.7

Table 5.4: Covariates - LC MNL Model

	Overall	'high density preference'	'medium density preference'	'low density preference'	'very low density preference'
Prioritisation when choosing current dwelling (on scale of 1-5)					
Commute via car	2.5	2.0	2.6	2.7	2.7
Commute via bus	3.1	3.3	3.0	3.3	2.9
Commute via walk/cycle	3.1	3.7	2.8	3.2	2.5
Near shops	3.5	3.8	3.3	3.6	2.9
Near schools	2.3	1.5	2.4	2.5	3.2
Was affordable	4.0	3.9	4.3	3.7	4.1
Had a section	3.5	2.8	3.4	3.8	4.2
Was a standalone home	3.0	2.1	3.1	3.3	4.0
Had parking	3.0	2.3	3.4	3.1	3.3
Mean	2.0	2.3	2.2	1.8	1.7
Demographic Variables					
% Female	55%	59%	54%	59%	46%
Age - Mean	39	34	37	44	42
Income - Mean (\$)	66,762	51,567	55,911	81,306	81,584
<i>Household Type</i>					
Single	13%	17%	16%	16%	3%
Couple	20%	20%	23%	26%	13%
Flat	25%	46%	25%	15%	8%
Family	40%	17%	32%	43%	76%
% commuting to central city	62%	78%	57%	56%	53%
% using active transport	30%	50%	27%	22%	15%
Housing and Neighbourhood Variables					
Number of bedrooms	2.9	2.4	2.9	3.0	3.6
<i>Dwelling Type</i>					
Apartment	7%	15%	5%	5%	0%
Townhouse / Flat	27%	43%	31%	22%	7%
Standalone house	66%	43%	64%	73%	93%
<i>Neighbourhood Density</i>					
Unknown	7%	5%	7%	6%	13%
High	16%	31%	8%	16%	4%
Medium	21%	30%	24%	20%	7%
Low/Very Low	56%	35%	61%	58%	77%
<i>Transport Preference</i>					
Public Transport	15%	11%	17%	18%	13%
Cycle	16%	15%	16%	14%	20%
Walk	49%	66%	39%	46%	40%
Drive	20%	9%	28%	22%	26%

A latent class model with four classes was identified as the best fitting model, as measured by the normalised BIC (Bayesian Information Criterion) (Nylund, Asparouhov, & Muthén, 2007). The four preference groups were named according to respondents' preference toward neighbourhood densities.

Results from the four class LC model (Table 5.3) show that two of the attributes – outdoor space, and neighbourhood density have opposing signs in different class groups. This result indicates that the groups have distinct preferences and that a homogeneous approach to analysing this data as in

a one class MNL model may be inappropriate, as coefficients with opposing signs may have the effect of negating one another. In addition, the LC model is much more effective than the simple MNL model at predicting residential choices, with a higher R^2 value (0.47 vs 0.24), suggesting that a LC approach is useful in this case. The R^2 value is relatively high for a study on this topic; R^2 values for past studies on housing and neighbourhood attributes are around 0.25 (Liao et al., 2015; Walker & Li, 2007; Yeoman & Akehurst, 2015).

Preference groups

The high density preference group (28% of the sample) has a clear preference for medium to high density living. From the coefficients reported in Table 5.3, it can be seen that they ideally prefer a townhouse, a small section, off-street parking, and a medium density, high destination accessibility neighbourhood. Price is the most important attribute and destination accessibility is the second most important attribute for this group when choosing where to live. It is interesting to note that for this group a small section or even a porch/balcony is more highly valued than a large section and that neighbourhood density is relatively unimportant to the group (although low density is disfavoured). In Table 5.4 we see that this group has the lowest average income. It also had the lowest average age and the highest percentage of commuters, with more than three quarters of the group currently commuting to the Wellington CBD. The most common household types are flats, couples, and singles and only a small minority (15%) are family households.

The medium density preference group (24% of the sample) shows a preference for low to medium density housing. They would ideally prefer a standalone house, a small section, a low density, high destination accessibility neighbourhood, and off-street parking. The most important attribute is price and the second most important attribute is parking. While the average for all groups was that parking was the fourth most important attribute, for this group it was the second most important. While they would ideally prefer a low density neighbourhood, density is less important than destination accessibility and price and they are likely to choose a medium density neighbourhood if it offers high accessibility at an affordable price. This group has lower than average income and lower than average age. The most common household types are couples, families and flats, and one third of these households are family households.

The low density preference group (26% of the sample) has a preference for low density, relatively accessible living. They would ideally prefer a standalone house, a large section, a medium density, high destination accessibility neighbourhood, and off-street parking. The most important attribute is destination accessibility and the second most important attribute is outdoor space. Townhouses and small sections also have positive coefficients, suggesting that these higher density attributes may be chosen in exchange for higher destination accessibility. While a large section is preferred,

a small section provides 73% of the utility of a large section. The most common household types are families, couples, and singles. This group was equally likely to choose a dwelling at each of the four price levels used in the study; this suggests that respondents may not have attended to the price attribute when choosing dwellings in the choice experiment.

The very low density preference group (21% of the sample) has a strong preference for low density living. They would ideally prefer a standalone house with a large section, off-street parking, and a low density neighbourhood with medium destination accessibility. The most important attribute is dwelling type and the second most important attribute is outdoor space. Although this group does not prioritise accessibility as much as the other groups do when choosing where to live, three quarters would prefer to walk, cycle, or take public transit to work. Unlike other groups, they prefer medium destination accessibility over high destination accessibility. Although this group is likely to continue to choose traditional standalone dwellings with sections as long as that option is price competitive, the group would be willing to choose a small section rather than a large one in order to live in a more accessible neighbourhood. The most common household types in this class are families and couples. Three quarters of households are family households.

Table 5.5: Willingness to pay (for a 1 bedroom dwelling) in \$ and % of median market rent

Housing Attributes	MNL Model		LC Model					
	Overall		'high density preference'		'medium density preference'		'very low density preference'	
<i>Dwelling Type</i>	\$	%	\$	%	\$	%	\$	%
Apartment	-38	-19	-13	-4	-11	-8.0	-137	-92
Townhouse	35	18	9	4	3	2.2	16	7
Standalone house	3	1	2	-1	8	5.7	121	85
<i>Outdoor Space</i>								
None	-43	-21	-17	-7	-15	-7.3	-167	-99
Porch / balcony	6	3	1	2	-4	-1.9	1	-2
Small section	18	9	17	7	13	6.2	75	42
Large section	19	10	-1	-2	6	3.0	90	59
<i>Destination Accessibility</i>								
High	56	29	58	25	15	6.7	13	4
Medium	27	14	29	13	4	2.6	14	11
Low	-83	-43	-88	-38	-19	-9.3	-28	-16
<i>Neighbourhood Density</i>								
High	-8	-5	0	1	0	-1.0	9	7
Medium	-2	-1	6	2	-4	-1.6	-26	-14
Low	10	5	-6	-3	4	2.6	17	7
<i>Parking</i>								
None	-29	-14	-15	-6	-24	-12.9	-15	-9
On-street	3	2	2	2	3	1.5	0	5
Off-street	26	13	12	4	21	11.4	15	4

Note: Positive values have green backgrounds and negative values have red backgrounds.

Willingness to pay

One of the advantages of discrete choice experiments is the ability to estimate respondents' willingness to pay (WTP) for particular housing and neighbourhood attributes. Willingness to pay is calculated by dividing the negative of the class specific utility coefficient for an attribute level by the class specific utility coefficient for price (Vermunt & Magidson, 2013). An estimation of willingness to pay values by class group is presented in Table 5.5. Willingness to pay values are expressed in dollars, assuming weekly rent for a one bedroom dwelling, and also by the percentage of median market rent (dwelling price).

As discussed previously, respondents adopt decision-making strategies to simplify the choice process. One of many possible strategies is to ignore a specific attribute, referred to as attribute non-attendance in the literature (Hensher, Rose, & Greene, 2011; Scarpa, Thiene, & Hensher, 2010). In the current study, the low density group was equally likely to choose a dwelling at each of the four price levels used in the study; this suggests that they did not attend to the price attribute when choosing dwellings in the choice experiment and this results in unrealistically high willingness to pay values. In these cases it is inappropriate to derive willingness to pay values from stated choice study results as they do not represent the valuation of attributes by respondents. Therefore, willingness to pay values were excluded for the low density preference group.

Results suggest that respondents in the high density preference group would on average be willing to pay around \$58 per week for high destination accessibility, \$29 per week for medium accessibility, and “-\$88” per week for low accessibility (Table 5.5). The strongly negative values imputed for the very low density preference group for apartments and lack of outdoor space are also notable.

5.9 Past and current preferences

Another component of the survey asked respondents to rate on a five point Likert scale the importance of 16 housing and neighbourhood attributes (including transport accessibility) when they were choosing their current dwelling. This allowed us to both gain an understanding of the importance of the six attributes included in the stated choice experiment relative to other housing and neighbourhood attributes and to gain an understanding of the temporal aspect of preferences (i.e. how do past priorities relate to current location and preferences). The mean rating of the attributes (1 - Not at all important, 5 - Extremely Important) by preference group (along with the standard deviation of the rating of each attribute) is shown in Figure 5.8. Differences in response ratings between preference groups were statistically significant at the 99% confidence interval for

11 of the 16 attributes (Mann-Whitney U test)¹. ‘Was affordable’ and ‘was warm/dry’ were among the top three most important attributes for all four preference groups and the difference in rating of these variables was not statistically significant across the groups. This suggests that the preference groups, while having different preferences with regard to many housing and density related attributes, also share in common a prioritisation of these two attributes and may choose residential locations or dwellings based on these, rather than other attributes more directly linked to density. At the same time, cold and damp taken together is the most common problem with dwellings, suggesting both that these attributes drive choices and that demand for warm, dry homes is to some extent unmet in the market (Statistics New Zealand, 2013b). The largest differences in mean rating of attributes between groups were for ‘standalone house’, ‘outdoor space’, and ‘near desirable schools’, which were all given more importance by the very low density preference group than the high density preference group. Conversely, ‘commute via walk/cycle’ and ‘near shops’ were rated relatively highly by the high density preference group and relatively low by the very low density preference group. Three attributes that were not included in the stated choice experiment had statistically significant differences in responses across the preference groups: ‘architectural style’, ‘safe neighbourhood’, and ‘near desirable schools’. All three were rated more highly by the very low density preference group than by the high density preference group. This suggests that the stated choice experiment included most of the attributes that determine the choice of neighbourhood density, but that these other factors also play a role.

Ratings of past priorities were consistent with current stated preferences. This suggests that respondents’ preferences were relatively stable over time. However, it is possible that respondents had difficulty recalling past preferences and instead substituted current preferences, as they are easier to mentally recall.

5.10 Preferences and current location

Analysis and comparison of housing and neighbourhood preferences to actual housing and neighbourhood type can shed light on the issue of self-selection from a new perspective. Comparing residential and travel preferences with actual residential location and travel modes can provide insight into the relationship between choices, preferences, and the impact of the built environment on behaviour. It should be noted that the intention of this study is not to establish a causal relationship between preferences and the choice of built environment. Rather, it is intended to shed light on the frequency with which individuals achieve their desired residential preferences and travel modes and the potential correlation between the two. Figures 5.9, 5.10, and 5.11 contrast

¹ A Mann-Whitney U Test is a non-parametric test of the hypothesis that two samples come from the same population (McKnight & Najab, 2010).

respondents' preference group with current neighbourhood density, destination accessibility, and dwelling type. Actual (current) neighbourhood density, destination accessibility, and dwelling type are strongly related to group membership, suggesting that results from the stated choice experiment were closely linked to actual choices of housing and neighbourhood type. Over 80% of those with a very low density preference live in a standalone house in a low density neighbourhood, suggesting that this preference is able to be met in the current market for the majority of households (Figure 5.11).

Figure 5.8

In contrast, those in the high density preference group are relatively evenly split between low, medium, and high density neighbourhoods and standalone houses, townhouses, and apartments (Figures 5.10 and 5.11). This would seem to suggest that there is an unmet demand for high density living in Wellington City. However, preferences for high density in this context can largely be seen as a preference for high destination accessibility, with households willing to live in higher density housing in order to achieve high destination accessibility (this can be seen in the relative size of the coefficients in Table 5.3). In light of this, examination of destination accessibility for those in the medium and high density preference groups may be more helpful to understanding levels of neighbourhood dissonance (i.e. divergence between preferred and current accessibility). About three quarters of 'high density preference' respondents live in neighbourhoods with high destination accessibility and about three quarters of 'medium density preference' respondents live in neighbourhoods with medium to high destination accessibility. This suggests that the desired level of destination accessibility is able to be met for most households in the current market, without necessarily living in higher density housing.

However, 18% of respondents in the medium and high density preference groups currently live in a neighbourhood with low destination accessibility and could be said to have a strong level of neighbourhood dissonance. These households are willing to live in higher density neighbourhoods and would largely prefer alternatives to car travel, yet live in areas that are car dependent. Understanding the factors that lead those with a medium to high density preference to live in low density areas is important. Potential factors for this that have been identified in previous studies include: affordability, dwelling size, dwelling quality, and lifestyle factors such as children and pets.

To test what variables are associated with living in a preferred neighbourhood type, a stepwise linear regression of the dependent variable 'has desired destination accessibility' on 18 potential explanatory factors (such as household type, dwelling size, and tenure), for those with a medium or high density preference was conducted. The best fitting model had an adjusted R^2 value of 0.19, with the explanatory variables tenure, prioritised walking commute, and prioritised safe neighbourhood in the respondents' choice of existing residence (Table 5.6).

Table 5.6: Summary table of regression

	Coefficient	Standard Error	p-value
Prioritised walking	0.265	0.021	0.000
Own home	-0.209	0.061	0.002
Prioritised safe neighbourhood	-0.142	0.026	0.021

Figure 5.9

Figure 5.10

Figure 5.11

Figure 5.12

Figure 5.13

“Walking distance to destinations” prioritised had the highest coefficient, with residents being more likely to live in their preferred neighbourhood if they had prioritised walking in their choice of current neighbourhood. This may suggest that some respondents may not have prioritised accessibility as much in past location choice decisions as they did in the choice experiment. Owner-occupiers were less likely to live in a neighbourhood with their preferred destination accessibility, while length of tenure was not a significant predictor of neighbourhood consonance. It is possible that owner-occupiers tend to become more locked in to a particular dwelling and their attachment to it is traded off against destination accessibility. ‘Safe neighbourhood’ prioritised was associated with residents being less likely to live in their preferred neighbourhood.

5.11 Implications for sustainable transport

Figure 5.12 shows preferred transport mode by current neighbourhood density and Figure 5.13 shows the use of preferred commute mode by current neighbourhood density. Current neighbourhood density is strongly correlated with travel mode as well as travel preference. However, across all groups, only a minority would prefer to drive to work. This suggests that many of those choosing car-oriented suburbs choose to do so in spite of (rather than because of) their transport preferences. Results from this study suggest that accessibility via walking, cycling, and

public transport would be appreciated across all neighbourhood types. This is consistent with the results in Betanzo (2012) who also studied preferences in Wellington City.

5.12 Conclusion

This study has employed a discrete choice experiment in combination with a latent class MNL model to explore residential preferences as they relate to housing, and neighbourhood, including transport accessibility. A stated choice approach to investigating residential preferences has proved valuable, as it can shed light on the demand for products which are not widespread in the current market. The current study investigated the potential demand for medium and high density housing in Wellington City. Medium and high density housing types are a relatively new addition to the housing stock within the City and are available in relatively few attribute combinations. Future research on this topic could investigate the extent to which built environment or other features are a barrier to alternatives to car travel.

This research indicates that many more people in Wellington City may be willing to live in medium and high density areas than currently live in such neighbourhoods (Figures 5.9 - 5.12). Those with a preference for low density are much more likely to live in their preferred neighbourhood than those with a preference for higher density and higher accessibility.

The majority of residents in Wellington City have a preference in principle for alternatives to car travel. Prioritisation of destination accessibility relative to housing type and outdoor space appears to be very important in the shaping of residential preference, and thus the ability to use alternatives to car travel. Nevertheless, the highest priorities for households when they chose their current dwelling were found to be affordability and warmth/dryness. This suggests that density related factors may often take a backseat to these concerns. While Wellington City has the highest density and the lowest percentage of commuters driving in New Zealand, it is still a city that is dominated by low density neighbourhoods and standalone dwellings. The results from this study suggest that there is an unmet demand for alternatives to car travel and that over half of residents would be willing to live in medium to high density housing in order to have higher destination accessibility.

CHAPTER 6

GROWTH SCENARIOS MODEL

6.1 Introduction

For those seeking to improve environmental and social outcomes, the ability of compact development to accommodate future population growth has long been a topic of interest. The potential for compact development is dependent on both physical conditions (such as physical geography, infrastructure) and socio-cultural conditions (such as demand for compact development, local regulation and policy, public opinion towards development types). Various approaches to achieving an increase in compact, transit oriented development have been proposed, with some being more ‘top down’ in approach where regulations are intended to drive the direction of development, and others being more market oriented in approach where consumer preferences are intended to drive the direction of development.

This chapter sheds light on this topic by contrasting a ‘top down’ model of residential development, where development patterns are determined based on local government priorities, and a ‘bottom up’ model, where development patterns are based on consumer preferences, using Wellington City as a case study. The ‘top down’ model of residential development was developed for Wellington City Council by an external consultant along with city planners for local planning purposes (id Consulting Limited, 2014). This growth scenario is intended to reflect the pattern of development under the current planning regime as well as demographic trends and economic forces (discussed in more detail in Chapter 2). The ‘bottom up’ model is constructed using the results of the stated choice study (discussed in more detail in Chapter 5). This chapter begins with an overview of the literature on the housing market in New Zealand, presents a revealed preference analysis of the current housing market in Wellington City, and discusses the formulation of the bottom up model. It goes on to contrast the results of the bottom up and top down models, and concludes with a discussion of the potential spatial distribution of housing development in Wellington City over the next 30 years.

Housing markets are complex and their operation is determined by the actions and interactions between multiple actors. The current housing supply is determined by several interacting factors, including but not limited to: historical supply, demand from residents, developers’ priorities and perceptions of market demand when building new developments, planning restrictions, demographic trends, and other external factors such as interest rates, finance availability, and potential alternative markets for investment. In light of this complexity, a simplified demand based model of future housing development is presented in this chapter. The model is intended to highlight the potential impacts of two of these factors, demand from residents for housing attributes (specifically those that are controlled through the district planning process) and land use

planning regulations that influence the form and distribution of housing throughout the city. The potential impact of these two factors on the geographical distribution of additional housing stock and the types of housing built across the city in the next 30 years is then examined.

6.2 New Zealand research

Housing market behaviour has been a subject of concentrated interest in New Zealand over the past decade due to concerns over housing affordability and rapid increases in housing prices. As a result, the nature and determinants of housing prices have been the subject of considerable research. Housing prices in New Zealand's cities are a product of demand, which is increasingly concentrated in the country's main urban centres (especially Auckland, New Zealand's largest city), and supply, which is relatively inelastic due to multiple factors, including planning constraints, limited amounts of buildable land, low construction productivity, and infrastructure requirements (Productivity Commission, 2015; The New Zealand Productivity Commission, 2012).

Murphy (2015) argues that the conception of housing affordability as a problem, the evidence based used in decision-making, and the choice of policy solutions, are inherently political processes that are influenced by political ideologies and interests, as well as power struggles between institutions. For example, when accessing the housing affordability problem in New Zealand, the national government has relied on the Annual Demographia International Housing Affordability Survey, which has repeatedly ranked Auckland as severely unaffordable (Murphy, 2014). However, if the percentage of household expenditure spent on housing and transport is used as a measure of affordability, the Auckland housing market appears to be affordable, with households spending less on housing and transport than in 17 of 18 US cities. This is due to lower transport costs than in other international cities (Nunns, 2014a). Conceptions of affordability can therefore influence policy formation and the type and location of housing built in New Zealand cities (Murphy, 2015).

Lees (2014) used a monocentric city model of development in Auckland to examine the impact of planning restrictions on housing costs in Auckland City. While Auckland is a polycentric city, the monocentric model was effective at predicting housing costs in Auckland City. Restrictions on infill development were found to increase the cost of housing by 0.76% and restrictions on outward expansion to increase the cost of housing by 0.70%. Land use restrictions were found to decrease density and increase land prices within 15 kilometres of the CBD, and increase development further from the city centre. It is important to note that in the study, a monocentric city model was used to access the influence of planning rules, a model which is static in time. The housing market is subject to considerable time lags, with the current distribution of housing being

due to historical demand and planning rules as well as current planning rules and demand. As a result, disparities between actual and projected prices and densities could be due to time lags rather than current planning restrictions.

Parker (2015) examined the impact of housing supply on affordability in Auckland City. While strong demand for housing is driven by population and economic growth, planning and design constraints were found to significantly limit the response of supply to demand. Grimes & Liang (2008) used a monocentric city model to examine the impact of Auckland's metropolitan limit on housing prices in the City. While prices generally fall with distance from the CBD, the urban limit increased the value of land just within the urban limit to 10 times that of land just outside the boundary.

The New Zealand Productivity Commission (2015) conducted an inquiry into the capacity of land for housing in New Zealand cities and its impact on housing affordability. The inquiry found that while many of New Zealand's larger cities have chosen to pursue a compact urban form, they often have difficulty implementing this strategy due to interests that resist efforts at urban intensification in existing neighbourhoods. Supply responses to demand for housing were found to be restricted by stringent land use regulations, such as height restrictions, restrictions on greenfield development, and restrictions on infill, resulting in increases in housing costs.

Nunns (2014) conducted an analysis of residential densities across New Zealand and Australian cities. While smaller cities experienced steady to declining population densities even during population growth, New Zealand's two largest cities (Auckland and Wellington) experienced a marked increase in population weighted density from 2001 to 2013. Auckland's density increased from 32.4 persons per hectare (pp/ha) to 43.1 pp/ha while Wellington's density increased from 32.2 pp/ha to 37.8 pp/ha from 2001 to 2013. In both regions, this was primarily driven by increases in density within 4 kilometres of the city centre. This would seem to suggest that there has been a strong demand for living centrally, where transport costs tend to be lower. Alternatively, this could be interpreted as intensification due to market distortion, mainly in the form of planning restrictions which limit the supply of greenfield land for housing development and can potentially increase housing costs.

Yeoman and Akehurst (2015) examined the housing preferences of Auckland households with regard to location, type, price and size. The authors calculated the structure of the housing stock that would be demanded based on stated preferences and compared it with the current housing stock. The study focused on preferences for dwelling types rather than location, and concluded

that the population would prefer less detached housing and more medium and high density housing than is available in the current market. While 76% of dwellings in Auckland are currently standalone dwellings, the study found that many households would choose a multi-unit dwelling in order to live more centrally and only 52% of households would choose standalone dwellings if given a choice between accessibility and dwelling type.

6.3 The Wellington housing market

The spatial extent, density, and land prices in urban areas have been shown to be generally well explained using the monocentric city model (Bertaud, 2015). In the model, household location choices are assumed to be the result of a trade-off between destination accessibility, floor area or density, and price. High prices and high density close to the central city are reflective of a monocentric development pattern and valuation of destination accessibility. As a result, density and price fall with distance to the city centre and the nature of this decline is determined by transport infrastructure and the valuation of destination accessibility.

Wellington is New Zealand's capital and second largest city, with a population of 190,959 in 2013. The City is expected to grow by between 16,900 and 70,100 from 2013 to 2043 (Statistics New Zealand, 2015b). Figure 6.1 shows the correlation between median market rent and distance to the CBD, using Wellington Town Hall as a proxy (101 Wakefield St)², by the most common dwelling type for each dwelling size (number of bedrooms), for suburbs in Wellington City in 2014-2015³. Figure 6.2 shows the same relationship for all dwelling types, showing fitted curves only for purposes of clarity (four or more bedroom apartments and townhouses were excluded due to a limited number of data points). Median market rent is strongly correlated with distance to the CBD when controlling for dwelling size and type. This strongly suggests that Wellington City follows the pattern of a monocentric city, a notion which is also strongly supported by employment centralisation. 49% of jobs in the City are located in the CBD area units of Wellington Central, Willis-St Cambridge Terrace, and Thorndon and the Wellington CBD has the highest employment density in New Zealand. The area unit with the next largest number of jobs is 'Adelaide' (Adelaide Road, Newtown), with 5% of the jobs in the City (Statistics New Zealand, 2015a; Statistics New

² The location of City Hall is frequently used as a proxy for the centre of the city; for an example see Wilson, Plane, Mackun, Fishetti, & Goworowska (2012).

³ Market rent values were obtained from the Ministry of Business, Innovation, and Employment (MBIE). Rent values are collected for all privately rented dwellings from bonds lodged with Tenancy services. Data is collected by dwelling type, number of bedrooms, and location. MBIE aggregates market rent data into suburbs, which are comprised of census area units.

Zealand, 2013a), while the remaining census area units had between 0 and 1 per cent of the city's jobs.

Several relationships between price, distance to CBD, and dwelling size are striking in Figure 6.2. The relationship between price and distance to CBD is logarithmic but the gradient varies by dwelling size. As dwelling size increases, the steepness of the curve, and thus the premium for centrally located dwellings, increases. The relative difference in price between dwelling sizes is relatively consistent regardless of distance to the CBD. For all dwelling sizes, standalone houses are the dwelling type with the highest price, followed by apartments, with flats/townhouses having the lowest rental price. This may be reflective of MBIE categorisation of dwelling types; townhouses, flats and other subdivided dwellings are grouped together. As flats and other subdivided dwellings are often at the lower end of the market, this may distort values and make townhouses appear to be of lower rental value than apartments.

Taken collectively, these rental price patterns have several potential implications for the geographic distribution of dwellings in the city. Residents of one and two bedroom dwellings appear to be much more likely to be able to live centrally than their counterparts in larger dwellings, as the relative cost of doing so is relatively low. For example, residents of a one bedroom apartment

Figure 6.1

Source: Author, using data from MBIE (2015)

Figure 6.2

would be expected to pay 41% more to live in the central city as opposed to on the city fringe, whereas residents of a three bedroom apartment would be expected to pay 63% more and residents of a four bedroom standalone house would be expected to pay 67% more to live centrally as opposed to on the city fringe. Wellington has a relatively high population density gradient as compared to other global cities; this is due to relatively high density in the central city as compared to the rest of the city, and lacks the gradual decrease in density seen in many other world cities (Bertaud & Malpezzi, 2003).

Figure 6.3 shows the number of dwellings built in each size category in Wellington City from 2001 to 2013, and contrasts this with the number of residents per household, the number of bedrooms that would have been demanded if new dwellings matched the occupancy rates of current households, and the number of bedrooms that would have been demanded if new dwellings had a higher number of occupants per bedroom – an ‘ideal’ occupancy⁴. Eaquib & Eaquib (2015) argue that houses are generally larger than is ‘needed’ as the number of three and four bedroom households built is larger than the number of three and four person households. However, ‘need’ is a loose concept, and (actual) revealed demand is more helpful. We can see that expecting that

⁴ In 2013, the average number of persons per bedroom was 1.48, 1.06, .94, and .85 for dwellings with 1, 2, 3 and 4 or more bedrooms, respectively. The high occupancy scenario assumes that the average number of bedrooms per person is 1.5, 1.0, 1.0, and 0.95 for dwellings with 1, 2, 3 and 4 or more bedrooms, respectively.

Figure 6.3

Source: Author, using data from the 2001 and 2013 census

no households will have more bedrooms than occupants is highly unrealistic. Furthermore, the number of one bedroom dwellings built between 2001 and 2013 was higher than would have been indicated by current occupancy rates while the number of dwellings with three or more bedrooms was lower than would have been indicated by current occupancy rates. This suggests that the supply of new dwellings in Wellington is modestly decreasing rather than increasing average dwelling sizes, and that the size of new dwellings is not larger than what is demanded.

Figure 6.4 shows the geographical distribution of dwellings built between 2001 and 2013 in Wellington City. There is a strong relationship between size of dwelling built and distance to the CBD. Almost all (93%) one bedroom dwellings were built within five kilometres of the CBD, with most being built within the CBD itself. Most two bedroom dwellings were also built in the CBD and surrounding suburbs, with 89% built within five kilometres of the CBD. In contrast, dwellings with three or more bedrooms tended to be built in the outer suburbs rather than in the central city and inner suburbs, with only 19% built within two kilometres and 43% built within five kilometres of the CBD.

Figure 6.4

Source: Author, using data from the 2001 and 2013 census

Figure 6.5 shows weighted population density by distance to the Wellington CBD in 2001 and 2013. Like other monocentric cities, density increases with proximity to the CBD in a logarithmic fashion (the logarithmic functions have R^2 values of around 0.8). Both the average density and the density gradient increased between 2001 and 2013. In the 20th century, cities across developed countries followed a general pattern of falling density over time, although there has been a reversal of this trend in the past decade in some US cities. According to the monocentric city model, the density of cities can largely be explained by the relative cost and valuation of housing and transport; increases in densities in cities can be due to increases in commuting costs, increases in the valuation of time, and/or restrictions on the outward expansion of cities (due to planning restrictions, high value agricultural land, or physical geography) (Bertaud, 2015; Bertaud & Malpezzi, 2003; Edlund, Machado, & Sviathci, 2015).

Several factors could influence density and the distribution of dwellings across geographic space in New Zealand cities, including the cost of housing relative to transport, changing housing, neighbourhood, and transport preferences, and planning restrictions. Research on preferences over time suggests that there is a growing preference for compact, accessible development (Refer to Chapters 3 and 5). In New Zealand, transport costs increased by 34.2% and the general

Figure 6.5

Source: Author, using data from the 2001 and 2013 census

consumer price index increased by 35.2% from 2001 to 2013. In Wellington City rental prices increased by 24.5%. Over the same time period, wages increased by 48.6% (Reserve Bank of New Zealand, 2016). This higher increase in transport costs relative to housing costs would suggest an increasing amount of development closer to city centres and a concurrent increase in housing density, as transport costs constitute a greater share of costs for housing further from the city centre. Edlund et al. (2015) argue that in major US cities, increasing density has been the result of increasing hours worked, and a resulting increased valuation of leisure time, especially among educated professionals.

Unlike US cities, however, Wellington City has seen a decrease in hours worked for full time workers; 29% of full time workers worked 50 hours or more per week in 2001 as compared to 22% in 2013, and the percentage of those working part time rather than full time has remained unchanged, suggesting that preferences in New Zealand towards shorter commutes may not be driven by reduced leisure time due to longer working hours (Statistics New Zealand, 2013a). Outward expansion is strictly controlled in Wellington City; 19% of the city's land is designated as a greenbelt reserve that is intended to contain the spatial extent of the city and a further 52% of the city's land area is zoned as rural land which cannot be subdivided for residential development.

About 50 hectares of greenfield land is zoned and consented for residential development, and a further 400 hectares has been zoned for residential development since 2003 but has yet to be consented. Collectively, the city estimates that about 2,700 new dwellings will be built in these greenfield areas from 2013 to 2043 (id Consulting Limited, 2014; Wellington City Council, 2011). Although this analysis is limited to Wellington City, it is important to note that greenfield expansion is not as strictly controlled in the surrounding territorial authorities as it is in Wellington City. Therefore, restrictions on greenfield expansion could result in either a concentration of development in existing suburbs in Wellington City or a shift in development from Wellington City to the surrounding area. Wellington's trend of increasing density near the city centre over the past decade could be due to an increasing valuation of compact development and destination accessibility, decreased relative costs of living centrally, zoning restrictions that limit outward expansion of the city, all of the above.

6.4 Trends in affordability and deprivation

Trends within the city can also influence and interact with wider housing and transport trends in the region. Morrison (2011) argues that the growth in the central city population in Wellington has resulted in an increased suburbanisation of less advantaged groups, where they face higher transport costs. Trends in affordability, deprivation, and transport in the wider region are briefly examined

Figure 6.6 shows combined housing costs plus actual (in the sense of experienced) transport costs for Wellington region area units within 50 kilometres of the Wellington CBD. Rent (based on data from the 2013 census)⁵ was adjusted for variation in the number of bedrooms per dwelling. Transport costs reflect the number of full and part time commuters per area unit, as well as experienced average commute length (km) in the area unit. There is a weak ($R^2=0.17$) but statistically significant ($p < .001$) negative relationship between combined housing and transport costs and distance to the Wellington CBD, suggesting that combined costs tend to decrease marginally with increasing distance to the CBD.

⁵ Median rent for each area unit was divided the by the median number of bedrooms in the area and multiplied by three, as the average number of bedrooms in the region was 3.03 in 2013.

Figure 6.6

Figure 6.7

Source: Author, using data from the 2013 census

Source: Author, using data from the 2013 census

Figure 6.7 shows distance to the Wellington CBD and average experienced commute lengths for workers commuting to work on census day in 2013. Average commute length is closely related to distance to the CBD. Average commute length increases with distance to the CBD, although at a much lower rate than would be expected if all workers commuted to the CBD (this would be the red line). For example, in area units 20 kilometres from the CBD, the average commute length is 9 kilometres. This pattern explains why combined housing plus actual commute costs fall with distance to the CBD; those living further out are much more likely to work in the local parts of the region rather than in the Wellington CBD.

Figure 6.8 shows the change in deprivation score from 1996 to 2013, for Wellington region area units within 50 kilometres of the CBD. Deprivation scores in New Zealand ranged from 800 to 1356, with a change in score of 20 roughly approximating a unit change in decile rating. Deprivation has remained fairly constant over the past 17 years, with 84% of area units in the Wellington region changing one decile or less over that time. If there had been a trend towards increasing suburbanisation of deprivation and poverty over the past two decades, a positive relationship between distance to the CBD and change in deprivation score would be expected.

Figure 6.8

Source: Author, using data from the 1996 and 2013 Deprivation Index

There was not a statistically significant relationship ($p=.23$) between proximity to central Wellington and change in deprivation score, suggesting that other factors besides centrality have influenced trends in deprivation.

Changes in rent show a similar pattern. Figure 6.9 shows the percentage change in median rent in Wellington region area units from 2001 to 2013. While there has been a wide variation in percentage change, ranging from 15% to 190%, there was not a statistically significant relationship ($p=.85$) between distance to the CBD and change in weekly rent. While relative rents do tend to be higher closer to the central city, it appears that rents have risen at an equal pace across the eight territorial authorities in the region (i.e. the fitted line in Figure 6.9 is flat).

Figure 6.9

Source: Author, using data from the 2001 and 2013 census

Figure 6.10 shows the relationship between distance (km) to the Wellington CBD and the percent of commuters in an area commuting by driving and walking/cycling (percentage using public transport is not shown). Active transport tends to increase with distance to the city centre, while driving tends to increase. Residents of Wellington City area units are much more likely to commute by active transport than residents of the wider region. There are only three area units outside of

Figure 6.10

Source: Author, using data from the 2013 census

Wellington City where more than 20% of commuters use active transit; these correspond to the city centres of Porirua, Petone, and Lower Hutt City.

In short, an examination of trends in affordability and deprivation in the Wellington region suggests that there has not been a decrease in the relative rental affordability of Wellington City as compared to the wider region. However, residents of more distant parts of the wider region do tend to have marginally lower combined housing and ‘actual’ transport costs on average, as compared to residents of Wellington City. This is due to both lower rents in more distant locations and a decreasing likelihood of working in the Wellington CBD for residents living further from the central city. Residents of Wellington City are considerably more likely to commute by active transport than residents elsewhere in the region. This is concerning, as it suggests the considerable health benefits of active travel and disbenefits of driving accrue inequitably across the region.

6.5 Commuting Costs

A key determinant of household location choice is destination accessibility, specifically with regard to commuting. As such, the transport infrastructure provided in a city has critical impacts on location choice, transport mode, and the urban form of the city. Figures 6.11 and 6.12 show predicted commuting costs by distance to the CBD for those commuting by public transport and car, respectively. Commuting costs are calculated using the methods described in Lees (2015).

Each household is assumed to have 1.35 workers. The cost of time is assumed to be two thirds of the hourly wage (\$18.48 per hour), which is a relatively modest assumption as it is slightly lower than the cost of time figure in the NZTA Economic Evaluation Manual (2013), \$21.06 per hour. Operating costs for private vehicles are assumed to be \$0.77 per kilometre, the Inland Revenue mileage rate, which includes the cost of repairs and maintenance, purchase prices, and the cost of fuel (Inland Revenue, 2015). For both those driving and taking public transport, commuting costs increase with distance to the CBD. For drivers, costs increase in a linear pattern and the majority of the costs incurred are operating costs. For public transport users, fare costs increase in a stepwise fashion and the majority of costs incurred are time costs.

Figure 6.11

Figure 6.12

Figure 6.13 shows total predicted commuting costs by distance to CBD for four transport modes: driving, public transport, walking, and cycling. When parking costs are subsidized and are not internalised into the cost of driving, driving is the lowest cost commute mode regardless of distance to the CBD. When parking costs are not subsidized, driving is cheaper than public transport within 8.5 km of the CBD, and public transport is cheaper than driving beyond 8.5 km from the CBD⁶. Driving and cycling are tied for the lowest cost mode for commutes between 2.5 kilometres and 5 kilometres. Walking is the lowest cost mode for commutes of less than 2.5 kilometres. Figure 6.13 emphasizes the importance of residential location on the ability to use active transport modes; active transport modes (walking and cycling) are not cost-competitive with other modes for those living more than 7 kilometres from the CBD, assuming a typical valuation of travel time and assuming that the benefits of active transport are not included in calculations. It also highlights the importance of parking costs for commute mode choice; if parking costs are subsidized by either the city or employers, commuters will be more likely to drive rather than use any other commute mode. The importance of parking for commute mode choice has been seen in previous studies, with commuters disproportionately driving in the presence of subsidized parking, even when both

Figure 6.13

⁶ Parking costs were assumed to be \$50 a week after a review of advertised parking prices in the Wellington CBD. This cost was omitted in the subsidised parking scenario.

driving and public transport are subsidized by employers (Hamre & Buehler, 2014). This pricing structure does not include externalised costs, such as the cost of carbon emissions and localised air pollution, which would make driving less cost competitive with other modes if they were internalised into the cost of driving for individuals.

The relative cost of commuting by distance to the CBD (Figure 6.13) relatively accurately predicts active transport use but not the choice between driving and public transport in Wellington City. For all 10 area units within 2.5 km of the CBD, walking is the most common commute mode. For 65 of the 66 area units between 2.5 and 17 km of the CBD, driving is the most common commute mode. Low cycling rates between 2.5 and 4.5 kilometres of the CBD, despite its cost competitiveness with driving, can be explained by the almost complete lack of cycling infrastructure in the City, a variable which is difficult to incorporate in cost calculations of commute modes. Relatively low public transport use between 8.5 and 17 kilometres of the CBD could be due to subsidized driving, a higher valuation of travel time, or a preference towards driving that outweighs cost considerations for commuters.

Figure 6.14: Costs by number of bedrooms

Figure 6.14 shows combined yearly commute and rent costs by distance to CBD for residents of 1, 2, 3, and 4 bedroom dwellings, using the median rent by distance for the most common dwelling type in each dwelling size category. The commute cost used is for the lowest cost commute mode at a given distance from the CBD (estimated using driving with unsubsidized parking). For one and two bedroom dwellings, combined costs are fairly evenly split between rent and commuting costs, while for three and four bedrooms dwellings most of the combined costs incurred are housing costs. The standard monocentric city model assumes that combined commute and housing costs are equal across the city, regardless of distance to the CBD, as the market is assumed to be in equilibrium and land use is assumed to be Pareto optimal. However, combined commute and housing costs in Wellington City follow a different pattern. For one and two bedroom dwellings, total costs generally increase with distance to the CBD. For three and four bedrooms dwellings, total costs follow a U-shape, with the central city and city fringe areas having the highest combined cost. Prices are most flat for three bedroom dwellings, with a 9% difference between the highest and lowest cost location. Prices are most variable for one bedroom dwellings, with a 44% difference between the highest and lowest cost location.

Figure 6.15 shows the combined annual housing and commute costs for the most common type of dwelling in each size category, and highlights the lowest cost residential location for each

Figure 6.15

category. For a one bedroom dwelling the lowest cost location is within the CBD, for a two bedroom dwelling the lowest cost location is one kilometre from the CBD, for a three bedroom dwelling the lowest cost location is 8 kilometres from the CBD, and for a four bedroom dwelling the lowest cost location is 9 kilometres from the CBD. For a one bedroom dwelling, 21% of household income is spent on housing and transport at the lowest cost location; this figure is 26% for a two bedroom dwelling, 37% for a three bedroom dwelling, and 42% for a four bedroom dwelling.⁷ These 'optimal' distances will be somewhat sensitive to the number of commuters in a household, wage rates, fluctuating commuting costs, and where workers actually work should they not work in the CBD, but are an indication of how dwelling and household size generally influence the relative affordability of different areas in the City.

6.6 Model Specification

The previous section demonstrated that over 70% of the variation in housing prices across Wellington City can be explained by the dwelling type, distance to the CBD, and the number of bedrooms in the dwelling. Given this, the six variables used in the stated choice study (dwelling type, destination accessibility, number of bedrooms, parking, neighbourhood density, and price), are an appropriate basis from which to develop a model of housing and neighbourhood choice.

The demand based housing model outlined here projects the number and type of newly constructed dwellings (both new construction and alterations) rather than the whole housing market. It is split into five-year time periods. In each period, the dwellings built are those that are the most preferred by residents and are thus assumed to be most demanded. The model is executed in an 8 step process as follows:

1. The projected growth in total number of dwellings from 2013 to 2043 is determined.
2. The allocation of the projected number of dwellings into dwelling size categories (1, 2, 3, 4 or more bedrooms) is determined.
3. Geographic submarkets, approximately equal to the neighbourhoods and variation in housing locations in the City, are identified.
4. Housing attributes (dwelling type, neighbourhood density, destination accessibility, outdoor space, parking, and price) in each size bedroom category within a geographic submarket are specified.
5. Capacity constraints on growth in each submarket are determined.

⁷ This is assuming that all households have 1.35 adults working full time, earning a median income. Larger dwellings are in fact likely to have a higher average number of working adults. Statistics NZ publishes the number of residents by number of bedrooms, but not the number of adults (or employed adults) by number of bedrooms.

6. Growth in new dwellings is allocated to submarkets for the five year period, assuming that preferences for the defined attributes are the driver of the distribution of growth.⁸
7. Capacity and housing attributes in each submarket are adjusted according to growth over the previous five year period.
8. Growth is allocated for the next five year period, with growth and adjustment of parameters continuing until the end of the sixth five-year period, 2043.

The formulation and assumptions used in each of these steps is described in further detail below.

1. Projected growth in number of dwellings

One goal of this study is to provide insight into the growth trajectory of a New Zealand City and to be useful for local Wellington policy makers for planning purposes. Therefore it is useful for the assumptions used in the study to be as similar to those used in Wellington City Council growth projections as possible. For purposes of comparability, the overall population growth assumptions used in this study are those used by Wellington City Council (i.d Consulting Limited, 2014). Another potential source of population projections is the territorial area level population projections produced by Statistics New Zealand. Statistics New Zealand produces three projection series: low, medium, and high population growth. Relative to these series, the Wellington City Council projections fall between the low and medium growth trajectories. Under Wellington City Council projections, the City is expected to grow by 46,270 people, or 20,672 households, between 2013 and 2043. In this sense, the model is ‘closed’; residents can move within the city but population growth is fixed.⁹ In the model, growth is set at 20,672 dwellings.

2. Projected growth by size of dwellings

Future demand for dwellings in each size category was determined using two datasets, current distribution of household types into dwelling sizes and future projections of growth by household type. Single person households and couples without dependants are the two household types expected to experience the most growth in the coming decades. Together these two household types are expected to account for 68% of the growth in households from 2013 to 2043, while families with dependent children and multi-person households are expected to account for 22% and 9% of new households respectively.

⁸ The model assumes that preferences shown by the data (from 2014-2015) will remain unchanged over the next 30 years, while preferences seem to be shifting towards compact and centrally located development types. As such, the results are likely a conservative estimate for the market for these housing types.

⁹ In reality, housing supply will both influence and be influenced by population growth, and growth in the city relative to adjacent areas will be influenced by urban planning rules as well as other factors.

The other main driver of demand for dwellings of varying sizes over the next 30 years is changing trends in the house sizes preferred by various household types. Dwelling occupancy rates and room occupancy rates have dropped considerably since 1951, due to both a decrease in average household size and an increase in the average number of rooms in dwellings (Morrison, 1994). Figure 6.16 shows the distribution of Wellington City households across dwelling sizes at the 2013 census. Demand for dwellings with three or more bedrooms is higher than might be expected given household sizes due to a large number of one and two person households living in dwellings with three or more bedrooms. This may be due to several factors, such as increasing incomes and preferences for larger homes, as well as empty nesters being slow or reluctant to relocate to smaller dwellings after their children have left home.

The fact that most future growth in households is expected to comprise one and two person households would seem to suggest that the majority of demand for future dwellings would be for smaller dwellings. However, given that nearly half of one and two person households currently live in dwellings with 3 or more bedrooms, this seems unlikely. Given that the historic trend in New Zealand has been a steady increase in dwelling sizes over the past century (despite decreasing household sizes), the pattern of low occupation rates seems likely to continue into the future, if not to become more pronounced as incomes continue to rise (Quotable Value, New Zealand,

Figure 6.16

Source: Author, using data from the 2013 census

2011)¹⁰. In the present study's model, the proportions of various household types are assumed to change as in WCC projections, and are projected to demand dwellings of varying bedroom sizes according to the distribution in 2013. The resulting projected demand for dwellings from 2013 to

Table 6.1

Forecast dwellings by number of residents, 2013-2043

	1 resident	2 residents	3 residents	4 residents	5 residents	6 or more residents	Total
1 bedroom	2,800	253	52	11	4	1	3,120
2 bedrooms	3,188	786	709	259	42	15	4,999
3 bedrooms	2,390	911	1,887	1,521	395	137	7,242
4 or more bedrooms	693	459	1,092	1,690	902	470	5,307
Total	9,075	2,409	3,740	3,481	1,343	624	20,672

2043 by size is shown in Table 6.1.¹¹ 39% of dwellings demanded are for 1 and 2 bedroom dwellings and 61% are for dwellings with three or more bedrooms.

3. Identification of geographic submarkets

The other key dimension on which this model must be comparable to city projections is geographic scale. Modelling spatial choices, including residential location, presents a number of problems related to geographic scale that can be tackled in a number of ways in modelling exercises. Firstly, choice sets that are too large can present data management and computer processing problems and it is often impossible to gather data on the characteristics of all potential alternatives on a fine-grained level (Ben-Akiva & Lerman, 1985). Secondly, one of the central assumptions for most discrete choice models for most goods is that individuals are able to consider all potential alternatives when making a choice. In the case of residential location choice, individuals are not likely to evaluate all potential alternatives and instead choose from an identified subset of options (Fotheringham & Curtis, 1999; Vega & Reynolds-Feighan, 2009). As a result, models of residential location choice often aggregate residential location alternatives into larger geographic units, the size of which varies from study to study.

In this study, Wellington City was split into 36 geographic units, approximately corresponding to the major neighbourhoods of the city. These were chosen as they are the areas used for population growth modelling by Wellington City Council, and this level of aggregation ensures that accurate data are available for each of the attributes used in the study. The three submarkets with more than

¹⁰ In the UK, number of bedrooms is closely correlated with floor area, although average room size, and thus the relationship between number of bedrooms and floor area, has changed slightly over the past 150 years (Roy, 2008).

¹¹ A small percentage of forecast dwellings demanded may be described as overcrowded. However, as this is intended as a model of demand rather than socially desirable outcomes this was not corrected.

5,000 dwellings (Karori, Tawa - Grenada North – Takapu Valley, and Te Aro), were split into two submarkets to allow for similar scale. The final submarkets ranged in 2013 population sizes from 344 (Makara) to 10,298 (Johnsonville), with an average population per submarket of 2,514. Submarkets ranged in area from 16 (Oriental Bay) to 17,011 hectares (Makara).

4. Specification of attributes within each dwelling size category

Submarkets were assigned dwelling or neighbourhood attributes using the most accurate data available; the attribute values chosen were the median or modal (most common) attribute value in that submarket, and are intended to represent a typical dwelling in each submarket, for each dwelling size category in the submarket. Attributes were specified for each submarket, with separate sets for each size category (1, 2, 3, and 4 or more bedroom) of dwellings in each submarket. For example, for the Wadestown submarket, the attribute values for a 2 bedroom dwelling are: standalone house, small section, medium destination accessibility, low neighbourhood density, off-street parking, and \$495 a week.

Dwelling type

Dwelling types were determined using tenancy data from the Ministry of Business Innovation and Employment (MBIE). MBIE separates Wellington City into 21 geographic areas for the purposes of collecting tenancy data, as opposed to the 36 geographic areas used in the study (although both are based on amalgamation of census area units). The dwelling type for each choice set was assumed to be the most commonly rented dwelling type for each bedroom category in the MBIE defined geographic area (Ministry of Business Innovation and Employment, 2015). Because the scale is more granular, some submarket attributes may be listed as the same type, which may not have been the case if the data were collected as separate units. Another potential source of data on dwelling types is the New Zealand census. However, the census only records dwelling type using two categories: a 'detached separate house' or 'two or more flats/units/townhouses/apartments/houses joined together' and as such does not provide a sufficient level of detail for this exercise. MBIE data was checked against dwelling types in the 2013 census to confirm that the most common dwelling type was either a standalone dwelling or a multi-unit dwelling.

Outdoor space

Outdoor space was determined using data on neighbourhood density, neighbourhood type, and dwelling type. The type of outdoor space for central city apartments was determined using data from the Central City Apartment Dwellers Survey, which is a survey of central city apartment

dwellers conducted by the City (Wellington City Council, 2009). In 2009, 75% of respondents reported having a porch or courtyard and 25% reported having no access to outdoor space. Therefore, in the model, three of the four central city submarkets are assigned a porch/balcony as outdoor space, and one central city submarket (the one with the lowest market rent) is assigned no outdoor space. For townhouses and standalone houses outside the CBD, data on available outdoor space was not available, although lot sizes and neighbourhood density are informative. For standalone houses and townhouses, outdoor space was determined by the neighbourhood's density. This was chosen as a metric because neighbourhood density is closely related to lot size and built up area, and thus outdoor space per dwelling. Townhouses were assumed to have a small section in medium density neighbourhoods and a porch/balcony in high density neighbourhoods. Standalone dwellings in low density areas were assumed to have a large section and standalone dwellings in medium density areas were assumed to have a small section.

Neighbourhood density

In the stated choice survey, neighbourhood density was described to respondents as the mix of housing types in the neighbourhood: 'primarily standalone homes', 'a mix of standalone homes, townhouses and apartments', or 'primarily apartments/townhouses'. For consistency, a numerical indication of population density can be related to this descriptive metric, i.e. population density is used as a metric of the mix of housing types in the neighbourhood.

This was done by performing a simple regression relating the weighted population density of a census area unit to the percentage of dwellings that are standalone in that area unit, for the 79 area units in Wellington City (Figure 6.17). Density and mix of housing types are strongly correlated ($R^2 = 0.77$). For areas with a low population density (less than 50pp/ha), 48 of 51 census area units have 60 percent or more standalone homes. For areas with a medium population density (50-100 pp/ha), 9 of 11 census area units have between 30 and 60 percent standalone dwellings, equivalent to a mix of standalone and multi-unit dwellings. For areas with a high population density (100 or more pp/ha), four of five census area units have less than 30 percent standalone dwellings, equivalent to a neighbourhood of primarily multi-unit dwellings. In the model, low density areas were assumed to be 'primarily standalone houses', medium density areas were assumed to be 'a mix of townhouses, standalone houses, and apartments', and high density areas were assumed to be 'primarily apartments/townhouses'.

Figure 6. 17

Source: Author. using data from the 2013 census

Parking

For central city submarkets, results from the Wellington City Council central city apartment dwellers survey were used. For other areas, neighbourhood age and district planning rules were used. Parking is a dwelling attribute that is strictly controlled by the district planning process. As such, the predominant type of parking in a geographical area is largely determined by the age when areas were built and the planning rules that were in effect at the time. Submarkets located in inner city suburbs were assumed to have on-street parking. Submarkets located in outer suburbs were assumed to have off-street parking.

Price

In the model, prices over time must be defined. In the stated choice study it was necessary to choose a measure for respondents to value dwellings with, with the options being rent values, house values, or the choice of either depending on the respondent's preference. Price-to-rent ratio is a useful tool to analyse the price of buying versus renting, and thus the relationship between these two indicators of dwelling costs. Of OECD nations, New Zealand's price-to-rent ratio has the highest percentage over valuation relative to long term averages, suggesting that the market is vulnerable to a price correction, either in the form of decreased house prices, increased rents, or a combination of both (Girouard, Kennedy, van den Noord, & André, 2006; OECD, 2015)¹².

¹² The OECD calculates price to rent ratios by dividing the nominal house price index by the rent price index for each country.

Figure 6.18

Source: Author, using data from the 2001 and 2013 census

Figure 6.19

Source: Author, using data from the 2001 and 2013 census

Nunns, Hitchins, & Owen (2015) conducted an analysis of price to rent ratios in Auckland and concluded that changes in the ratio of prices to rent over time are relatively consistent across Auckland and were primarily due to regional and national factors rather than localised factors. Rents were chosen as a measure in the present study as they have been more stable over time than house values, and rents are more likely to be understood by both renters and home owners. As ratios of price to rent are relatively consistent over time, rent values are an appropriate tool for measuring both rent and home ownership costs. Median market rent figures were obtained from the Ministry of Business, Innovation, and Employment.

For future house prices, the main question of interest is how relative prices across geographic space change over time, rather than how affordability changes in the housing market as a whole. A projection of future changes in prices over time is necessary for the model. Projecting changes in prices accurately is important as price is the single most important factor for individuals when choosing where to live. Relative prices across an urban area can be influenced by changes in density, transport costs, and population growth, among other factors (Anas, Arnott, & Small, 1998; Bertaud, 2015). Figure 6.18 juxtaposes median market rent per bedroom for all private rental dwellings in 2001 and 2013 with the number of new dwellings built between 2001 and 2013, by distance to the CBD. The median price of rental housing in Wellington City increased by 24.5% between the 2001 and 2013 censuses, while the Reserve Bank of New Zealand estimates the price of housing increased by 130.6% in New Zealand as a whole during the same time period (Reserve Bank of New Zealand, 2016).¹⁴

While changes in median rent were highly variable across census area units from 2001 to 2013, there appears to be no relationship ($R^2=0.02$) between distance to the CBD and percentage increase in market rent (Figure 6.19). There also does not appear to be a clear relationship between an increase in the number of dwellings in a geographic area over 2001 to 2013 and rental prices in that area (Figure 6.18). The single largest location of growth was the central city, which doubled its number of private rental dwellings and was the location of 29% of the city's dwelling growth from 2001 to 2013. However, change in median rent in the central city was close to the average at 21%, and was very similar to rent increases in other area units which experienced little or no growth.

Taken collectively, these trends seem to indicate that while median rent may fluctuate at a localised level, dwelling type, dwelling size, and distance to the CBD are the primary determinants of relative

¹⁴ The lesser gain in Wellington is more characteristic of cities in New Zealand outside Auckland. Prices in Auckland significantly raise the New Zealand average.

rental prices in Wellington City. The ability of these indicators to predict relative rental prices throughout the city has remained relatively constant over the past decade; rental prices have risen but they have risen at a similar rate across the City. While future changes in the geographical distribution of housing supply could potentially influence the relationship between distance to the CBD and housing prices, and gradually alter relative prices, new dwellings represent a relatively minor percentage of the dwelling stock and therefore influence prices only gradually. Therefore, in the present modelling exercise, relative prices between areas are treated as a constant, regardless of uneven growth in the number of new dwellings in different area units over time.

5. Adjustment according to growth

As growth in the dwelling stock occurs in each area, neighbourhood density, outdoor space, and the predominant dwelling type available would be expected to change. Each of these attributes was adjusted in the model every five years according to growth in dwellings. For areas where the density category increased from medium to high density, the new dwelling type available was assumed to be an apartment. For areas where the density category increased from low to medium density, the new dwelling type available was assumed to be a townhouse. Similarly, in areas which increased to medium density, the outdoor space was assumed to be a small section and in areas which increased to high density the outdoor space was assumed to be a porch.

6. Capacity Constraints

Most choice models are based on the assumption that each individual can choose between alternatives independently from other individuals' choices. When alternatives are limited in supply, the economic theory of supply and demand predicts that prices will increase and consumers with the highest willingness to pay will be able to purchase limited goods at a higher price. But this is not the case in several situations. Limitations and interactions can occur when the number of available alternatives is less than the total demand for this particular alternative. As a result, some consumers may be denied their most preferred choice (de Palma, Picard, & Waddell, 2007). In the case of housing, capacity constraints dictate that not all housing can be built in the area that is most preferred. Instead, development is spread across several of the most desired areas.

In Wellington City, capacity constraints on the pace of construction of housing were determined by reviewing historic population growth rates by census area unit. The capacity constraint used in this study is intended to be generous and to represent an approximation of what is technically possible, given demand, rather than what is socially or politically possible. Wellington's population grew by an average of 0.86% per year between 2006 and 2013, while the number of occupied

private dwellings grew by 2.1% per year over the same time period. High growth in dwellings relative to population growth is due to a growing number of one and two person households and a drop in average household size. The rate of growth in dwellings was very uneven across the City, reflecting uneven demand as well as uneven zoning restrictions. Due to zoning restrictions on infill development in other neighbourhoods, development can happen more rapidly in greenfield areas and in the central city than in other suburban areas. Over this time, the number of central city dwellings grew by an average of 14.1% per year. This growth was unevenly distributed between the three central city area units; the Willis St-Cambridge Terrace area unit grew by 27.8% per year, the Lambton area unit grew by 4.2% per year, and the Thorndon area unit grew by 2.0% per year. The number of dwellings in greenfield growth areas (Takapu, Woodridge, Grenada Village, Newlands East, Miramar West, and Churton Park North) grew by an average of 8.7% per year, and the number of dwellings in existing neighbourhoods grew by an average of 1.3% per year. Dwelling growth rates in existing neighbourhoods varied from -1.0% (Aro Valley) to 4.8% (Mt. Cook-Wallace St and Adelaide) per year.

In the model of projected development, some realistic constraints on growth rates are needed. It is assumed that a maximum of 5% of the current dwelling stock can be added each year in existing neighbourhoods, while in the central city and greenfield areas, a maximum of 10% of current dwellings can be added each year. These limits were chosen as past growth in existing may in some cases have been toward the low end of what is technically possible (as development in all existing areas has been relatively strictly controlled), whereas the growth seen in the central city over the past decade is unlikely to be able to continue at the same rate¹⁵. Once a submarket meets its capacity constraint, development in the model is assigned to the submarket with the next highest utility.

6.7 Validation

The ability of the model to accurately predict the spatial distribution of housing development was tested by simulating housing development in Wellington City from 2001 to 2013. For comparison with actual development patterns over this time period, constraints on development must be set to approximate those in the current District Plan. Hence, it was assumed that a maximum of 1% of the current dwelling stock could be added each year in existing neighbourhoods, while 10% could be added in the central city, and in greenfield areas a maximum of 5% of the current dwelling stock could be added each year. Figure 6.20 shows modelled and actual residential development

¹⁵ A large percentage of the growth in apartments was the result of one time conversion of offices into residences, a trend which is unlikely to continue unless there is a substantial loss of jobs in the central city.

over the period from 2001 to 2013. The model is relatively effective at predicting the percentage of development in the CBD (30.6 actual vs. 30.3% modelled), inner suburbs (39.0% actual vs 38.2% modelled), and outer suburbs (30.3% actual vs 31.6% modelled). While it accurately predicts development at a submarket level within 10 kilometres of the CBD, it is less effective at placing development within the outer suburban area 11-18 kilometres from the CBD.

Figure 6.20

6.8 Model Outputs

Figure 6.21 contrasts the actual number of new dwellings constructed from 2001 to 2013 with the modelled number of dwellings under a scenario where there are no district plan rules governing the spatial distribution of development in Wellington City. Whereas from 2001 to 2013 58% of development was within 5 kilometres of the CBD, 41% of development would have been within 5 kilometres of the CBD under the no District Plan rules scenario.

Looking further forward, Figure 6.22 presents modelled development from 2013 to 2043, again under a scenario where there are no district plan rules. Parking is not required, and townhouses and apartments, as well as dwellings with a porch/balcony rather than a section, can be built in all areas. The attributes of housing development in each submarket are the median of those available in 2013, with adjustments according to submarket growth.

Figure 6.23 presents the no district plan rules scenario by the preference group of households choosing each residential location, using the preference groups developed in Chapter 5. All central city apartment development is driven by the high density preference group. Dwellings for the medium density preference group are spread across inner suburban submarkets and Johnsonville (10 km from the CBD). Dwellings for the low

Figure 6.21

Figure 6.22

Figure 6.23

density preference group are in the outer suburban submarkets and all dwellings for the very low density preference group are greenfield development in Grenada North - Tawa - Takapu Valley.

Figure 6.24 presents modelled development over 2013-2043, under a scenario where the attributes of each submarket represent the most affordable, rather than the most common, dwelling in that submarket. Standalone dwellings are replaced with townhouses/flats and off-street parking is replaced with on-street parking. Figure 6.25 presents modelled development over 2013-2043, under a highly artificial scenario where all dwellings in all submarkets are the same price, regardless of their attributes. The results of the affordable and same price models underline how price tends to push residents out of the inner suburbs.

Figure 6.26 and 6.27 contrast the three modelled demand scenarios, the no district plan rules scenario, the affordable price scenario, and the same price scenario, with the Wellington City Council's projected model of residential development. All three versions of the demand based model project an increase of about 5,000 dwellings in the central city, suggesting that price has little impact on the decision to live centrally. In contrast, the WCC model projects that about 6,500 new central city dwellings will be built by 2043; by contrast, this study's modelling suggests that this may be larger than what is demanded given current preferences. Comparison of the three demand model scenarios suggests that price plays a strong role in the choice between inner and outer suburbs for many households. In the 'No rules' model 26% of new dwellings are in the inner suburbs, in the affordable price model 33% of new dwellings are in the inner suburbs, and 57% of new dwellings are in the inner suburbs if all locations are the same price. The low density preference group is the group whose location choices are most changeable; while they ideally prefer a standalone house on a large section, they are price sensitive and value destination accessibility, and many will be willing to live in higher density and closer to the CBD depending on the price. In contrast, the very low density preference group has a strong preference for low density housing, prefers medium destination accessibility to high destination accessibility, and would always choose low density housing on the city fringe if it was available.

Figure 6.24

Figure 6.25

Figure 6.26

Figure 6.27

6.9 Conclusion

The aim of this chapter was to examine the potential influence of preferences and planning on the spatial distribution of future housing development. This chapter began with a revealed preference analysis of housing and transport trends in Wellington City. Dwelling type, distance to the CBD, and dwelling size were shown to be the primary determinants of dwelling prices in the city. Distance to the CBD has a strong influence on housing prices, suggesting that residents strongly value low commute times as well as the other destination accessibility benefits of living centrally. The combined commuting and housing costs of living centrally were shown to be much larger for households living in dwellings with 3 and 4 bedrooms, suggesting that household size, and not preference alone, may be a determinant of choice of neighbourhood type, location in terms of distance to the CBD, and dwelling type. Living within five kilometres of the CBD was shown to be a determinant of ability to use active transport; living within 2.5 kilometres of the CBD is a primary determinant of the ability to walk to work, and living within five kilometres of the CBD is a primary determinant of the ability to cycle to work. Density and dwelling prices in Wellington both rose from 2001 to 2013. While price rose uniformly across the city, density rose within 5 kilometres of the CBD, with a large increase in dwellings within the CBD.

This chapter then examined the potential impact of consumer preferences on the spatial distribution of housing growth in Wellington City over the next 30 years and contrasted demand based growth scenarios with a planning based growth scenario. While the model focuses on housing attributes that are controlled or influenced through the district plan, the model is appropriate for modelling residential choice as it encompasses the key determinants of housing prices and residential location choice in Wellington City. While the previous chapter demonstrated that a considerable portion of the population in Wellington City has a preference in principle for centrally located, higher density housing, this chapter has demonstrated that there are in practice several real world factors that may prevent individuals from choosing their preferred housing and neighbourhood type. This chapter found that when considering the six attributes used in the study, the largest barrier to living in compact, active transport oriented neighbourhoods is price (affordability), rather than preferences regarding other attributes, especially for those looking for dwellings with a higher number of bedrooms. Those with a preference for high density/high accessibility are likely to choose central living regardless of relatively higher prices, and those with a low density preference are likely to choose low density housing further from the city centre as prices increase. The impact of price on the choice between higher density, central living as opposed to lower density, more distant residential locations is especially strong for the medium density

preference group, which represented about 28% of the survey sample. Housing prices and house sizes (number of bedrooms) are both strongly correlated with distance to the central city.

Many other studies have examined preferences for compact development in principle, implicitly assuming that compact and dispersed development were equally affordable, and found that more people would prefer to live in compact neighbourhoods than currently live in these neighbourhoods. The current study sheds light on this relationship by accounting for price differences across neighbourhoods, and has shown that understanding the relationship between price and destination accessibility is important to understanding household location choice. While about 58% of Wellington residents have a preference for medium to high density, centrally located housing, this study found that the other 42% of the population have a preference for low density housing and are very price sensitive. While destination accessibility benefits may encourage those with a low density preference to live in more centrally located, higher density areas, they will not do so if it is considerably more expensive than more distant, lower density areas.

Understanding consumer preferences and the current composition and trends among those choosing to live in medium and high density housing is critical to ensuring that planning for higher density in New Zealand cities is successful. In the case of Wellington City, which has relatively ambitious goals with regard to intensification and compact growth, this modelling exercise suggests that the planned amount of high density central city development appears to be somewhat higher than that demanded given current preferences, prices, and dwelling attributes. It also suggests that the current restrictions that limit the development of rural land on the city fringe likely limit greenfield development in these areas considerably. While there is substantial demand for low density greenfield development in Wellington, this is primarily driven by price; most households would prefer to live closer to the central city if it was more affordable. Efforts to make housing within 5 kilometres of the city more affordable would encourage more households to live centrally, an outcome that would both reduce housing costs and result in positive environmental outcomes. Many households would live in medium density housing within five kilometres of the CBD but would not prefer high density housing in the central city. The current planning restrictions in the City work against these preferences by limiting growth in neighbourhoods just outside the CBD. This finding is somewhat intuitive; one of the main driving forces behind the outward expansion of cities (sprawl) is households' search for affordable housing, so one of the main antidotes to sprawl is the provision of centrally located affordable housing. This is especially the case for larger households, as dwellings with a larger number of bedrooms escalate more in price the closer they are to the central city.

CHAPTER 7

APPLYING THE RESULTS:

IMPACT OF RESIDENTIAL DEVELOPMENT PATTERNS

7.1 Introduction

The spatial pattern of urban development has many impacts on both the environment and the lived experience of urban dwellers. In Wellington City, about 21,000 dwellings are projected to be built between 2013 and 2050; this means that over 23% of the city's housing stock in 2050 will be built over that time period. The spatial distribution of this development will have impacts on the dominant transport modes in the City, the health of its residents, the carbon emissions of the City, the affordability of housing, and the lived experience of the City's residents. This chapter uses the results from the growth scenarios model (Chapter 6), to calculate three important outcomes associated with different potential growth trajectories in Wellington City: carbon emissions from transport, the residential density of neighbourhoods, and housing affordability. The impacts of three growth trajectory scenarios on these outcomes are investigated. Two demand based scenarios (developed in Chapter 6) are investigated, one based on preferences given current rental prices and one based on preferences given more affordable rental prices. A third scenario, a planning based development scenario, was developed by Wellington City Council and reflects the city's planning goals. This growth scenario is intended to reflect the pattern of development under the current planning regime as well as demographic trends and economic forces (discussed in more detail in Chapter 2). The three key outcomes of interest, housing and transport costs, per capita emissions from land transport, and residential housing densities, are estimated for 33 geographic submarkets in Wellington City, and the relative impacts of the geographic distribution of future development across these submarkets is calculated. The chapter closes with a discussion of these various impacts.

7.2 Background

Higher housing densities are associated with numerous positive outcomes, including decreased carbon emissions from transport, increased physical activity from active transport, decreased government spending on infrastructure provision, and decreased conversion of open space to urban use (Ewing, Bartholomew, Winkleman, Walters, & Chen, 2007). At the same time, governments often face opposition from existing residents to increased density, especially in existing low density suburbs (Fischel, 2009).

Wellington City has adopted an ambitious carbon emissions reduction goal of an 80% reduction in citywide emissions by 2050 relative to 2001 levels. Council projections suggest that meeting this goal will require ambitious action across the City's three largest emissions categories: stationary energy use (38% of emissions), land transport (36% of emissions), and aviation (19% of emissions)

(URS New Zealand Limited, 2014; Wellington City Council, 2016). However, local government has relatively little control over emissions from stationary energy and aviation, as these emissions sources are strongly influenced by external factors, such as the energy mix imported from the national grid and demand for air travel. Land transport planning and governance, and thus control over emissions from land transport, is divided across three levels of government in Wellington. The local council controls land use planning as well as the provision of local roads and walking and cycling infrastructure, the regional council operates the public transport network and sets the strategic direction for transport investment in the region, and the national government makes transportation investment decisions and operates the State Highway that runs through the City. Given this governance structure, the primary means by which Wellington City can influence future carbon emissions from transport is through 1) the provision of walking and cycling infrastructure and 2) urban planning that encourages the use of public transport, walking, and cycling rather than driving. The location of new residential development in Wellington City is particularly relevant to emissions reductions as residential location plays a strong role in determining emissions from land transport and also influences household energy use. Almost all (over 99%) of emissions from passenger land transport are from private vehicle use; and the level of vehicle kilometres travelled (VKT) per capita varies greatly by residential location (Ewing & Cervero, 2010; Holtzclaw, Clear, Dittmar, Goldstein, & Haas, 2002; URS New Zealand Limited, 2014).

Housing affordability is a salient political issue in New Zealand. New Zealand's three largest cities, Auckland, Wellington, and Christchurch, have repeatedly been rated as severely unaffordable in affordability rankings of global cities, which has received considerable attention in New Zealand (Cox & Pavletich, 2016; The New Zealand Productivity Commission, 2012). Housing costs vary considerably across geographic space, a factor that is both relevant to individual household location choice decisions and government decision making when choosing where to allow future housing development. When comparing the cost of living in various locations, many analyses have omitted the transport costs associated with living at a given location (Cox & Pavletich, 2016). Such an approach is problematic as some areas that are considered affordable in terms of housing costs are often less so after accounting for transport costs due to the relative inaccessibility of employment and amenities (Nunns, 2014a). Murphy (2014) argues that the approach used by Cox and Pavletich (2016) fails to recognize the institutional and other factors that shape house prices and is overly relied upon by the New Zealand government. Understanding the potential impact of a city's residential development pattern on housing affordability, including the transportation costs associated with residential locations, is desirable.

Several studies in New Zealand have examined the relationship between residential location and housing and transport costs. Mattingly and Morrissey (2013) used median rent and commute data from the 2006 census in order to estimate average commute and housing costs for each CAU in Auckland City. Nunns (2014) used the same methodology, using data from the 2013 census, to estimate average commute and housing costs for CAUs in Auckland, Wellington, and Christchurch cities. Preval et al (2016) used a similar methodology to estimate the carbon emissions associated with proposed housing development locations in Auckland City. The study also examined impacts of housing development on housing density and water quality.

7.3 Calculating carbon emissions

Two sources of carbon emissions, household energy use and household travel patterns, are strongly influenced by household location. First, we briefly examine the estimation of household energy use and then we estimate carbon emissions from land transport. Current per capita land transport emissions are estimated by submarket in order to be able to estimate the relative carbon emissions associated with each growth scenario.

Household energy use

New Zealand data on household emissions are limited in quality due to the lack of robust surveys of household energy use. New Zealand has relatively high levels of household electricity use as compared to other developed nations, with the 6th highest per capita electricity use in the OECD (IEA, 2008). New Zealand's per capita electricity use is especially high considering that four of the five countries with higher electricity use (Norway, Canada, Sweden, and Finland) have considerably colder climates and thus a higher need for household heating than New Zealand. Energy use in New Zealand homes varies by household age, floor area, and heating source. While newer homes are more efficient than older homes on a per square metre basis, they also have larger average floor areas and thus have higher average energy use and emissions than older dwellings. In addition to these factors, emissions from household energy use in New Zealand are strongly dependent on the energy mix, as around 69% of the household energy used is in the form of electricity (Isaacs et al., 2010). Electricity generation in New Zealand is currently around 80% renewable (Chapman, 2008).

The New Zealand Household Energy End-use Project (HEEP) is the most comprehensive source of data on energy use in New Zealand households. The study (1999-2005) aimed to be representative at a national level, and includes detailed energy use data from 400 houses from throughout New Zealand. However, the sample has an insufficient number of recently constructed

dwelling or multi-unit dwellings to be able to draw conclusions on the relative energy expenditure of houses of varying densities, or the likely energy usage of housing built in the next 30 years, as less than one percent of houses in the study were multi-unit dwellings or were built after the year 2000, and heat pumps, now relatively common, were barely in use over the survey period. Another potential source of data on the relative energy use of different household types is the New Zealand Household Economic Survey, produced by Statistics New Zealand, which collects data on detailed household expenditure. However, the survey does not include data on the dwelling type or residential location. Statistics New Zealand publishes data on floor areas for consented dwellings, but does not publish this data by dwelling type or census area unit location.

Figure 7.1

Source: Author, using data from the NZ Greenhouse Gas Inventory, 1990-2014

Several factors, such as climate, building materials, energy sources, urban form, and urban area size, likely influence the levels of total household emissions in New Zealand relative to those of other nations. While Australia may be the closest in terms of geographic and cultural distance, the type and magnitude of emissions from household energy use in the two countries differ considerably. Cities such as Sydney and Adelaide have warmer climates that result in higher cooling related electricity use, and also rely on electricity that is primarily generated from coal rather than renewable sources. With regard to embodied energy in housing, Mithraratne (2001) found that most building materials had much less embodied energy in New Zealand as compared to Australia. For example, steel had 7.5 times higher embodied energy in Australia and concrete had 1.5 times higher embodied energy.

Figure 7.1 shows estimated New Zealand per capita household carbon emissions from 1990 to 2014, using data from the New Zealand greenhouse gas inventory (Ministry for the Environment, 2014). Light passenger travel was responsible for two thirds of household emissions in 2014, and household energy use was responsible for 21% of emissions. Per capita emissions from travel have increased by 15% since 1990. In contrast, per capita emissions from public electricity, household waste, and household fuel have decreased by 32%, 26%, and 17%, respectively since 1990. Given these trends, reducing emissions from household travel is the most challenging and urgent task when attempting to reduce household carbon emissions.

No New Zealand study has yet been conducted that either examines distance to urban centre or housing type, in regard to non-travel household energy use. There is currently insufficient data to calculate comprehensively the relationship between the spatial pattern of residential development and non-travel household energy use. Other factors, including the type of heating and levels of insulation, likely play significant roles in determining non-travel household energy use. However, as emissions from travel constitute the majority of household emissions and are responsible for the overall increase in household emissions from 1990 to 2014, urban form related variations in emissions from non-travel household energy use likely play a secondary role in determining the geographic pattern of overall household greenhouse gas emissions in New Zealand.

Figure 7.2

Source: New Zealand Household Travel Survey, 2011 - 2014

Transport

Two sources of emissions from land transport are calculated: commuting (by private vehicle, bus, and train) and non-commuting private vehicle travel. Emissions were calculated using two data sources, the New Zealand Census and the New Zealand Household Travel Survey. The New Zealand Census provides data on both the number of cars available per household and the mode of travel to work on census day, as well as the primary work location. These data are available at the census area unit level. The New Zealand Household Travel Survey collects more detailed data on household travel for all purposes, but is designed to be representative at a national level and thus does not have sufficient coverage for local level analysis (Figure 7.2).

Carbon emissions from commuting were calculated for each submarket using transport mode and trip length data from the 2013 census, as follows:

Equation 1: CO₂ emissions per average known commute for Submarket “i”

$$CommuteEmissions_{SUBi} = \left(\frac{Car_i}{Total_i} * Car\ km_i * \frac{EF_{Car}}{OC_i} + \frac{Train_i}{Total_i} * Train\ km_i * EF_{Train} + \frac{Bus_i}{Total_i} * Bus\ km_i * EF_{Bus} \right) / Total_i$$

where:

Car_i = The number of commutes on census day by private car or company car.

$Total_i$ = The total number of commutes on census day.

$Car\ km_i$ = The kilometres driven on census day, assuming a linear path from the CAU of residence to the CAU of the work location¹⁷.

EF_{Car} = The emissions factor, emissions per km per car, 0.23 kg CO₂ (Preval, Randal, & Chapman, 2016)

OC_{Car} = The commuting occupancy rate per car by CAU, which was calculated by dividing the number of people commuting by private car, company car, or as a car passenger, by the number of commutes (car journeys) by private car or company car.¹⁸

$Train_i$ = The number of commutes by train on census day.

$Train\ km_i$ = The kilometres travelled by train on census day, assuming a linear path from the nearest station in the CAU of residence to the nearest station to the CAU of the work location.

EF_{Train} = The Emissions per train passenger kilometre = (2.67 kg CO₂ / (1km/0.0148 L)) * 0.7 * (0.198 kg CO₂/0.509 kg CO₂) (Preval et al., 2016).

Bus_i = The number of commutes by bus on census day.

$Bus\ km_i$ = The kilometres travelled by bus on census day, assuming a linear path from the CAU of residence to the CAU of the work location.

EF_{Bus} = Emissions per bus passenger km = emissions per litre diesel/ passenger km per litre = 2.67 kg CO₂ / (1km/0.0365 L) (Preval et al., 2016).

¹⁷ This method will result in a systematic underestimate of commute lengths. While using commute length by road network would be more accurate, it is outside the scope of this study.

¹⁸ Trips driving children are counted as a separate trip type, ‘To accompany or transport someone else’ by Statistics New Zealand. As this is a calculation of commute trips, only car passengers travelling for commuting purposes are included in the car occupancy rate.

Estimation of emissions from non-commute trips requires a different approach as the census does not collect data on non-commute driving and household travel survey data is not available for all areas (Figure 7.3). Distance of non-commute driving were calculated for each submarket using CAU level data on household car ownership rates from the New Zealand Census, and regional level data on trip purposes and vehicle kilometres travelled from the New Zealand Household Travel Survey. Figure 7.2 shows the estimated kilometres driven per year by trip purpose for drivers in the Wellington region. Commuting to work or study constitutes 21%, travel for work purposes constitutes 14%,

Figure 7.3: Estimation of non-commuting carbon emissions

Figure 7.4

Source: New Zealand Census, 2013

and travelling for other personal purposes constitutes the remaining 65% of vehicle kilometres travelled. These figures highlight the importance of including non-commute driving in the calculation of carbon emissions from transport, as they constitute about two thirds of all driving, and thus are likely to be a proportionate share of carbon emissions from private land transport in the region.

The VKT per household has been shown to be related to the average number of cars owned per household in previous studies across several cities (Figure 7.5) (Cervero & Kockelman, 1997; Giuliano & Dargay, 2006; Holtzclaw, Clear, Dittmar, Goldstein, & Haas, 2002)¹⁹. Both of these variables are also strongly influenced by residential density; increasing density decreases both vehicle kilometres travelled and household car ownership (Holtzclaw et al., 2002).

In Wellington City, car ownership per household is strongly correlated to residential density and distance to the city centre. Figure 7.4 shows the level of car ownership by distance to the centre of the city, with the closest submarkets at the bottom of the chart and the most distant submarkets at the top. Households living in higher density areas close to the city centre are much less likely to

Figure 7.5

Source: New Zealand Census, 2013 and Holtzclaw, 2002

¹⁹ This is not to say that car ownership rates have a causative effect on VKT, although access to a car does influence the ability to drive. Rather, both figures are reflective of incomes, density, and other factors that determine the level of car use and ownership in a given area.

own a car than households living in lower density areas further from the city centre, and are more likely to own one car rather than two or three cars. In comparison with three US cities, Wellington City has relatively high levels of car ownership given residential density levels, with residential density having a comparatively less strong effect on levels of car ownership (Figure 7.5). This is consistent with OECD data indicating that New Zealand has the highest rates of automobile ownership in the OECD. Despite relatively high levels of car ownership, total VKT per capita in New Zealand is lower than in the US, although it is still the second highest in the OECD (OECD, 2013).

Many methods of projecting VKT based on car ownership in a geographic area are possible. Figure 7.5 represents two methods of projecting non-commute VKT from the number of vehicles per adult and the average kilometres travelled per year (from the Household Travel Survey) for the various submarkets in Wellington City. One method would be to adjust expected non-commuting VKT by assuming that adults in households without access to a car do not drive and that all adults in households with access to a car drive the regional average VKT (Model 1 in Figure 7.6).

This method will tend to over-estimate VKT for low car ownership households and under estimate VKT for high vehicle ownership households, as it is assumed that VKT is not greatly influenced

Figure 7.6

Source: Author, using data from the New Zealand Census, 2013 and the New Zealand Household Travel Survey

Figure 7.7

Source: Author, using data from Guiliano and Gargay, 2006 and Holtzclaw et al, 2002

by the level of vehicle access. Another method is to adjust VKT according to the number of vehicles available to each adult in the household, assuming there is a direct linear relationship between individual VKT and car access (e.g. a person with access to one car will drive twice as much as a person with access to 0.5 cars) (Model 2 in Figure 7.6). The second approach is used in this chapter, as it reflects the impact of density and car ownership on VKT.

Given the relationship between the number of cars available per adult and the number of vehicle kilometres driven per adult identified in previous studies (Figure 7.7), we use levels of car ownership per household, and thus the number of vehicles available per adult, to estimate non-commuting emissions, as follows:

Equation 2: CO₂ emissions from non-commute driving per average adult for given Submarket “i”

$$Emissions_i = \left(\frac{Carownership_i}{HouseholdSize_i} * CarKm * DrivingAdults_i \right) / Adults_i * EF_{Car}$$

where:

$Emissions_i$ = emissions in kg of CO₂ per year per adult in submarket i

$CarOwnership_i$ = The number of cars per household in the submarket

$HouseholdsSize_i$ = The total number of adults per household in the submarket.

CarKm = The expected number of non-commuting kilometres driven per year in the region given a ratio of one car per adult, 6309 kilometres (Ministry of Transport, 2014).

EF_{car} = The average emissions per km per car, 0.23 kg CO₂ (Preval et al., 2016).

DrivingAdults_i = The number of adults in the submarket with access to cars.

Adults_i = The total number of adults in the submarket.

Calculated VKT and emissions were compared to regional averages for purposes of validation. The above calculations result in an average per capita total land transport emissions of 726 kg CO₂. NZTA estimates that total car VKT per capita in the Wellington region is 7,366, using data from odometer readings (NZ Transport Agency, 2013). This would imply an annual average per capita emissions from land transport of 1,072 kg CO₂ in the region. As the NZTA figure includes trips for work purposes, calculated VKT should be expected to be 14% lower, around 921 kg CO₂. However, residents of Wellington City should be expected to have lower emissions than the regional average, as they are less likely to commute by car and also have shorter commutes. The estimated emissions from land transport calculated here appear to be reasonably accurate, although they are likely a slight underestimate of emissions per capita due to the use of linear commute distances.

7.4 Calculating housing affordability

This section calculates the relative housing affordability across submarkets in the City. Affordability is calculated from a private household point of view, and does not include social costs or costs borne by the government (such as health or infrastructure costs). Similarly to carbon emissions, the affordability of dwellings is heavily influenced by three main categories of costs that are borne directly by households: housing costs, transport costs, and household energy costs. These costs vary spatially both between cities and within cities, and the location of new development has impacts on the overall affordability of cities, regions, and countries (Nunns, 2014a). Here, we estimate the impact of future residential development scenarios on two of these costs, housing costs and transport costs, for Wellington City.

Transport costs were calculated as the sum of both commuting costs associated with the average commute in a submarket and the car ownership costs associated with car ownership rates in a submarket. The operating, parking, and fare costs associated with commuting were calculated as follows:

Equation 3: Commute Operating Costs per average known commute for given Submarket “i”

$$TransportCosts_i = \left(\frac{Car_i}{Total_i} * Car_{km_i} * Car_{Cost} + \frac{CBDCar_i}{Car_i} * Park_{Cost} + \frac{Train_i}{Total_i} * Train_{Cost} + \frac{Bus_i}{Total_i} * Bus_{Cost} \right)$$

where:

Car_i = The number of commutes on census day by private car or company car.

$Total_i$ = The total number of commutes on census day.

Car_{km_i} = The kilometres driven on census day, assuming a linear path from CAU of residence to the CAU of the work location.

Car_{Cost} = The operating cost per km driven, \$0.305 per km (New Zealand Transport Agency, 2013)²⁰.

$CBDCar_i$ = The number of commutes on census day by private car with a workplace within the Wellington CBD²¹.

$Park_{Cost}$ = The cost for parking within the Wellington CBD, \$50 per week.

$Train_i$ = The number of commutes by train on census day.

$Train_{Cost}$ = The cost of train travel from the nearest station in the CAU of residence to the station nearest the CAU of workplace location (Metlink, 2015).

Bus_i = The number of commutes by bus on census day.

Bus_{Cost} = The cost of bus travel from the nearest station in the CAU of residence to the station nearest the CAU of workplace location (Metlink, 2015).

The time costs associated with commuting were calculated as follows:

Equation 4: Commute Time Costs per average known commute for given Submarket “i”

$$TimeCosts_i = \left(\frac{Car_i}{Total_i} * Car_{V_{time}} * Car_{km} + \frac{Train_i}{Total_i} * Train_{Time} * V_{time} + \frac{Bus_i}{Total_i} * Bus_{time} * V_{time} + \frac{Bus_i}{Total_i} * Walk_{time} * V_{time} \right)$$

where:

Car_{km} = Kilometres of car journey.

$Car_{V_{time}}$ = Time cost of car travel per kilometre, 0.42 (Lees, 2015).

²⁰ This is a different figure than used in previous calculations, as it does not include the cost of car ownership, which is being calculated separately.

²¹ It is assumed that those commuting in a company car to the CBD and all commuters driving to locations outside the CBD do not have to pay for parking.

$\text{Train}_{\text{time}}$ = Time of train journey (Metlink, 2015).

V_{time} = Time cost of travel per hour, \$18.48 (Lees, 2015).

Bus_{time} = Time of bus journey (Metlink, 2015).

$\text{Walk}_{\text{time}}$ = kilometres travelled/5 kilometres/hr

Figure 7.8

An alternative method of calculating commuting costs would be to assume a CBD workplace location. This method would more accurately reflect the average costs expected for a household choosing between residential locations given an average (CBD) workplace location, as in Chapter 6. However, using actual workplace locations and actual mode of travel to work is more reflective of the actual commute costs experienced by households, as households living further from the CBD are less likely to commute into the CBD. The estimated total median transport costs associated with living in a given submarket, using both calculation methods, are shown in Figure 7.8. Actual workplaces were used in the calculation of commute costs.

Car ownership costs were estimated as follows.

Equation 5: Car Ownership Costs per household for given Submarket "i"

$$CarCosts_i = \frac{NCar_i}{NTotal_i} * OwnCost$$

where:

$NCar_i$ = The total number of cars owned in the submarket.

$Total_i$ = The total number of households in the submarket.

$CarCost$ = Average cost of car ownership, including vehicle registration, insurance, warrant of fitness, interest, and depreciation costs (Nunns, 2014a).

Housing costs were estimated as follows. Rent costs were calculated using median market rent figures, by dwelling type and number of bedrooms, obtained from the Ministry of Business, Innovation, and Employment (Ministry of Business Innovation and Employment, 2015). Dwelling size, type and location are key determinants of rental costs in Wellington City. While the demand based growth scenarios developed in this thesis project the number of dwellings in each submarket by type and size, the WCC development trajectory only projects the number of dwellings by submarket. For purposes of comparison, new dwellings in the WCC projection were assigned a size and type by assuming that new dwellings built in each submarket were equivalent in size and type to the current proportion of dwellings in that submarket.

Dwellings were then assigned the median market rent for dwellings of that size and type by area. The proportion of median income spent on housing and transport costs associated with living in a given submarket, assuming two commuting adults living in a three bedroom dwelling, are shown in Figure 7.9. Total costs are weakly correlated with distance to the CBD ($R^2=0.16$), with housing costs generally falling with distance to CBD and transport costs generally rising with distance to CBD.

Figure 7.9

Figure 7.10

Table 7. 1: Income, Commuters, and Dwelling Size by Household Type

Household Type	Median Income	Number of Full Time Working Adults	Number of Bedrooms
One Person Household	\$44,800*	1^	1^
Couple without Children	\$97,700*	2^	2^
Three Person Flat	\$123,900*	3^	3^
Single with Children	\$49,900*	1^	2^
Couple with Children	\$128,600*	1.46*	4^

*Median, Source: New Zealand Census, 2013, ^Data not available, assumed mode used

Expected total housing and transport costs associated with living in an area will vary by the type of household. Figure 7.10 presents the percent of median income spent on housing for five selected household types by area. The data and assumptions used for each household type are shown in Table 7.2. While housing affordability is often defined as households being able to spend less than 32% of their income on housing, this metric ignores the fact that transport costs also vary considerably by residential location and are a large component of household spending. *The housing and transport affordability index* defines affordability as households being able to spend less than 45% of their income on combined housing and transport costs, a measure that is more consistent with the typical costs associated with living in a given area (Isalou, Litman, & Shahmoradi, 2014; Mattingly & Morrissey, 2014). Using this definition of affordability and assuming a median household income and median rent, all Wellington City submarkets are affordable for couples without children, couples with children, and flatting adults. However, only 22 of 33 submarkets are affordable for an adult living alone and no submarkets are affordable for a single adult with children²².

7.5 Calculating density associated with growth scenarios

A standard approach to measuring population density is to calculate the number of residents per hectare. Figure 7.11 shows the impact of the three growth scenarios on population density in Wellington City, by distance to the CBD. Densities in 2013 (based on census data) are shown for comparison. While all three models see a considerable increase in population density within the CBD, the Wellington City Council scenario and the demand (affordable price) scenarios both result in 12 percent greater increases in density within the CBD as compared to the demand (current price) scenario.

While population density calculated as people per hectare is a useful method for measuring density, it is problematic when there are large areas with a small number of residents because it is very sensitive to the presence of sparsely populated land within a city's boundaries, resulting in a much lower measure of density than the density where an average resident lives. Population-weighted density better reflects the density of the neighbourhood experienced by an average inhabitant of the City (Glaeser & Kahn, 2004; Nunns, 2014b; Rappaport, 2008). Population weighted density

²² This is assuming that a household lives in private rental accommodation, and does not take into account social housing. However, incomes do take into account social welfare benefits.

was used to measure the potential impact of the two growth scenarios on population weighted density in the City, as follows.²³

Equation 5. Population weighted density

$$\sum_i^N \frac{P_i}{A_i} * \frac{P_i}{\sum_j^N P_j}$$

where P_i is the population of geographic area i and A_i is the spatial extent of geographic area i (in hectares) and geographic areas in the city are enumerated $i = 1, 2, 3, \dots, N$ (Nunns, 2014b).

The demand based (current price) scenario results in a population weighted density of 41.0 residents per hectare, the demand based (affordable price) scenario results in a population weighted density of 50.5 residents per hectare, and the WCC scenario results in a population weighted density of 44.2 residents per hectare in 2043. For comparison, Wellington City had a population weighted density of 28.0 residents per hectare in 2013.

Figure 7.11

²³ Population weighted density was not used for the submarket level density calculations as population weighted density requires density to be known at one level lower than that which is being calculated.

7.6 Carbon emissions from growth scenarios

The total transport emissions from commuting and non-commute driving, for an average resident of a given area, are shown in Figure 7.12. Emissions relative to population are shown in Figure 7.13. Submarkets close to the city centre have much lower emissions per capita and ‘emit less’ than their proportion of residents, while submarkets further from the city have higher emissions per capita and ‘emit more’ than their proportion of residents. Distance to the CBD is also correlated with the proportion of emissions due to commuting vs. non-commute driving. For areas within 3 kilometres of the CBD, 83% of emissions are from non-commute driving, while for areas greater than 8 kilometres from the CBD, only 65% of emissions are from non-commute driving.

For residents of dwellings built between 2013 and 2043, the demand (current price) scenario results in 36,045 tonnes CO₂ per year, the demand (affordable price) scenario results in 29,960 tonnes CO₂ per year and the WCC scenario results in 28,923 tonnes CO₂ per year. Of these estimates, 27% of emissions are from commuting and 73% are from non-commute driving. The relative emissions from land transport calculated here appear to be reasonably accurate, although they are more accurate for commuting emissions than non-commuting emissions. Future emissions will also be influenced by other factors, such as vehicle fuel efficiency, transport investments, changing preferences, the cost of fuel, and the pricing of carbon emissions.

Table 7.2: Average Yearly Rent and Transport Costs of Dwellings Built 2013-2043

	Demand Based Model			WCC Model		
Number of Bedrooms	Rent	Transport	Total	Rent	Transport	Total
1 Bedroom	\$ 14,262	\$ 6,638	\$ 20,900	\$ 16,209	\$ 8,080	\$ 24,290
2 Bedrooms	\$ 21,502	\$ 11,364	\$ 32,866	\$ 23,321	\$ 9,037	\$ 32,358
3 Bedrooms	\$ 24,898	\$ 12,707	\$ 37,605	\$ 27,626	\$ 11,612	\$ 39,238
4 Bedrooms	\$ 27,029	\$ 13,340	\$ 40,369	\$ 31,391	\$ 12,614	\$ 44,005
Overall	\$ 23,055	\$ 11,652	\$ 34,707	\$ 25,138	\$ 10,428	\$ 35,566
% of Income - Household Type	Rent	Transport	Total	Rent	Transport	Total
One Person Household	32%	15%	47%	36%	18%	54%
Couple without Children	22%	12%	34%	24%	9%	33%
Three Person Flat	20%	10%	30%	22%	9%	32%
Single with Children	43%	23%	66%	47%	18%	65%
Couple with Children	21%	10%	31%	24%	10%	34%
Overall	31%	16%	47%	34%	14%	48%

Figure 7.12

Figure 7.13

7.7 Housing affordability from growth scenarios

The spatial location of housing has been shown to influence both rent and transport costs, with rents generally declining with distance to the CBD and transport costs generally increasing with distance to the CBD. The potential impact of the demand based scenario and the WCC scenario on housing affordability was determined by calculating the average rent and transport cost of dwellings projected to be built under each development scenario (Table 7.2). The demand based model results in lower average combined costs for new 1, 3, and 4 bedroom dwellings, while the WCC model results in lower average costs for new 2 bedroom dwellings. The two models result in roughly equivalent overall average combined costs, with the demand based model showing an average combined cost 2.4% lower than the WCC model²⁴. Given 2013 household incomes (Table 7.2), the demand based model would result in an average newly built dwelling costing 47% of household income and the WCC model would result in an average dwelling costing 48% of household income (including both rent and transport costs) (Table 7.1).

²⁴ The demand (affordable price) scenario was excluded from this comparison as it is not based on actual or probable prices.

7.8 Conclusion

This chapter has reviewed the potential impact of three residential development scenarios for Wellington City on three outcomes: affordability, residential density, and carbon emissions from household transport. All three scenarios result in increased densities, reflecting the fact that both the planned 'WCC' scenario and the two demand based scenarios see the majority of new development located in existing neighbourhoods rather than on greenfield sites. All three scenarios see population weighted density increase from 28 pp/ha to over 40 pp/ha. This is significant as 35 pp/ha is the generally accepted threshold for high quality public transport provision (Newman & Kenworthy, 2006), suggesting that all future scenarios would result in public transport becoming more viable in Wellington City.

Wellington City Council's projected growth scenario results in better environmental outcomes than the demand (current price) scenario, both in terms of residential density and carbon emissions from transport. The WCC scenario results in the lowest carbon emissions of the three scenarios, reflecting the higher number of residents in the CBD, where transport emissions per capita are the lowest in the City. The WCC scenario results in higher rents for new dwellings built between 2013 and 2043 as compared to the demand based growth scenario. However, higher rents are almost offset by lower transport costs. The Wellington City Council plan for development results in combined housing and transport costs that are slightly higher than in a demand based growth scenario, although both scenarios result in prices that are slightly higher than a 45% of income affordability threshold for combined housing and transport costs. This highlights the importance of including transport costs in the calculation of living costs, as areas with higher rents often have proportionally lower transport costs.

While Wellington City Council's projected growth scenario for the City generally results in positive outcomes, care will need to be taken to ensure that this scenario is possible or likely to occur under the current District Plan, as current planning regulations can limit allowed densities and encourage car oriented development. Local levels of growth in the WCC scenario are based on both the number of developable sites in a suburb and the projected allowed amount of infill. However, these anticipated levels of growth may not be achieved if there is not sufficient demand for development in an area or if the planning rules limit development that would otherwise be demanded. While this study has viewed the level of population growth as fixed, it is important to remember that strict planning controls, even if intended to achieve environmental outcomes, may

shift population growth to other cities in the region, which would result in comparatively higher carbon emissions, even relative to those from the highest emitting areas of Wellington City. In other words, a policy designed to reduce carbon emissions could prove less effective if it were to increase carbon emissions as some households respond to increased housing costs by moving to more carbon intensive locations outside Wellington City. This might be referred to as carbon leakage.

Future research in New Zealand could add to knowledge of this topic by investigating residential energy use by household type and location. Such emissions are likely to vary by household type and location much as transport emissions and rents do. Investigation of total emissions per capita by residential location would also be desirable, as emissions from household consumption can constitute a considerable portion of total national carbon emissions per capita.

CHAPTER 8

DISCUSSION AND CONCLUSION

8.1 Introduction

In this final chapter of this thesis I provide a summary description of the work undertaken, a review of how the results may be relevant for policymakers, a discussion of directions for future research, and a critical evaluation of the thesis as a whole. This thesis has been an investigation into the potential for urban growth trajectories to achieve more sustainable outcomes in urban areas in New Zealand. This thesis investigated preferences towards housing, neighbourhood and transport attributes, as well as urban planning policies, on sustainable outcomes in the case of Wellington City, New Zealand. The topic is particularly significant for New Zealand as the great majority of the population lives in cities, historical development has been dominated by low density, standalone dwellings, and transport and urban form are two of the main domains in which the country can reduce its carbon emissions. Achieving more sustainable outcomes is reliant on both urban planning policies and public demand, as well as transport policies and investments.

Firstly, this thesis investigated how planning restrictions influence the provision of compact development in Wellington. It then used a stated choice study to investigate the extent to which there is an unmet demand for compact development and alternatives to car travel. Using the results of the stated choice study, it was able to model future development trajectories based on demand for housing, neighbourhood and transport attributes. Lastly it compared the impact of demand based and planning based growth trajectories on selected environmental and social outcomes.

8.2 Summary of Work Completed

This thesis is comprised of six parts: an analysis of the planning context in Wellington City, a literature review, a stated choice study of housing, neighbourhood, and travel preferences, an analysis of survey recruitment and distribution techniques, a model of future development scenarios, and an analysis of the impact of development scenarios on carbon emissions, density, and affordability. A brief summary of the findings from each of these chapters is as follows.

Chapter 2

Chapter 2 analysed historical and present urban planning and transport policies in Wellington City. Wellington's transport policy shows a pattern of path dependency: historical decisions to favour car oriented (rather than public transport or active transport oriented) investment have driven transport investment decisions in subsequent decades as well as influencing present mode shares and the ease of use of different transport modes. Urban planning policies show a similar pattern of path dependency: planning rules enacted in the 1960s endure in the present District Plan despite

being packaged with different justifications and existing within a different regulatory framework under the Resource Management Act.

While the first century of the City's development saw growth occur largely without planning policy, planning based growth began in the 1950s and 1960s, and reflected both modernist planning principles and the engineering backgrounds of early transport and land use planners in the City. Since the introduction of modern urban planning, the City has seen alternating periods of relatively lenient and stringent planning approaches. The rise of mandated public consultation in the urban planning process has had a significant influence on planning policy in Wellington City, and tended to make planning rules more prescriptive. Consultation has favoured some voices over others, with planning rules frequently reflecting the interests of local homeowners, including limiting density and new residential development in existing suburbs. Selective transport investments (which are largely influenced by national factors such as legislation and policy orientation), patterns of path dependency, and a strongly regulated planning process contribute to creating a housing market where the influence of demand on growth patterns and transport mode shares is constrained.

Chapter 3

Chapter 3 reviewed the international and New Zealand literature on compact urban development and its relationship to sustainable environmental outcomes and housing and transport preferences. Compact development is associated with reduced carbon emissions as well as other positive environmental and social outcomes, including increased physical activity from active transport, decreased cost of public service provision, decreased local air pollution, and decreased land used for residential development.

Proponents of compact, mixed use development often conduct research that seeks to justify this type of development by demonstrating that it provides travel behaviour benefits in the form of increased walking and cycling and decreased vehicle kilometres travelled. This framework for analysis implicitly assumes that regulations encouraging compact development are a justified policy intervention due to the benefits they provide to society, and that under normal market conditions, low density and outward expansion of cities would be the norm. While this body of research is valuable, this framework for analysis is somewhat problematic for two reasons. Firstly, it can be read as implying that low density, car oriented urban forms are the preferred development type, and that environmental benefits must be sufficiently large to justify depriving households of their preferred development type. Secondly, it may ignore the drivers of urban growth that lead to low

density, outward expansion of cities, which may often be due to market failures that need correction if a transition to compact, mixed use development is to be successful.

Previous research in New Zealand and in similar overseas countries has indicated an unmet demand for compact development, suggesting that the realisation of household preferences could assist in achieving sustainable outcomes and a reduction in emissions from car travel. Previous studies have demonstrated a mismatch between actual housing, neighbourhood, and transport mode choices, and preferences for these attributes, with a significant unmet demand for compact development and alternatives to car travel. However, a great deal of this research, particularly from environmental fields of study, has 1) neglected how price influences choice and preference for compact development, 2) failed to distinguish housing and neighbourhood preferences from travel preferences, and 3) tended to present relatively attractive and low density versions of compact development. Omitting the impact of price on location choice may result in both an over-estimate of demand for compact development and a lack of understanding of the conditions needed for preferences for compact development to be realised in the marketplace. Studies that fail to distinguish between housing, neighbourhood and travel preferences and studies that present relatively attractive and unrealistic version of compact development may inaccurately measure the mismatch between preferences and actual choices. Stated choice studies were introduced as a research method that allows for the incorporation of price and the measurement of preferences for discrete housing and neighbourhood attributes, when assessing demand for compact development.

Chapter 4

Chapter 4 investigated the relative merits of two electronically assisted survey distribution and recruitment techniques: a door to door recruitment with in-person completion via an electronic tablet computer, and online recruitment via an email list with completion via a web-browser based questionnaire. Electronically assisted survey techniques offer several advantages over traditional survey techniques, such as decreased survey processing time, an increased number of respondents, decreased administration costs, and the ability to tailor surveys to respondents. However, they can also potentially introduce biases, such as coverage biases and measurement error. Research into survey design is significant for social science researchers who seek to design representative surveys in the face of declining response rates and changing survey technologies. The current study adds to the literature on survey design and sampling techniques by holding survey presentation mode constant and separating the impacts of recruitment mode and completion mode on responses.

Survey recruitment mode appeared to influence both response rates and which socio-demographic groups were represented, with the door to door recruitment mode having both a higher response rate and a more socio-demographically representative sample. However, the difference between the two recruitment modes was relatively small. Completion mode appeared to have little or no impact on survey responses, although the in-person completion mode had much longer survey completion times. The internet distributed survey performed better with regard to time costs and the number of respondents obtained. Differences between the two survey modes appeared to be largely due to recruitment method rather than response mode.

Chapter 5

Chapter 5 analysed how people value and make trade-offs between housing, neighbourhood, and transport attributes when choosing where to live. To do this, residents living in a variety of neighbourhoods across the city were asked to complete a survey; 454 completed responses were received with about half completed in person and about half completed online. A latent class model was developed to examine the preferences of residents and the trade-offs they are willing to make when choosing where to live. This type of model allows for the identification of preference groups as a means of understanding the diversity of preferences across the population. Unlike other methods, it does not assume that groups can be defined *a priori* by factors such as age or education levels. Instead, groups are determined by respondents' preferences.

Four preference groups (latent classes) were identified based on the interaction of preferences for six attributes: neighbourhood density, outdoor space, dwelling type, parking availability, transport accessibility, and price. The very low density preference group (21% of the sample) was found to have a strong preference for a standalone house with a large section, and would prefer to live in a low density neighbourhood. They also have a preference for medium destination accessibility, but prioritise housing attributes over accessibility attributes. A second latent class was the low density preference group (26% of the sample) which has a strong preference for a standalone house with a large section, and would prefer to live in a low density neighbourhood. However, they also have a preference for high destination accessibility and are willing to choose a small section over a large section or a townhouse instead of a standalone house to live in a more accessible neighbourhood. A third group, the medium density preference group (24% of the sample) would ideally prefer a standalone house with a small section. However, they also prefer neighbourhoods with a mix of dwelling types and have a strong preference for destination accessibility. For this group, the affordability and the combination of attributes in a dwelling will determine whether low or medium density housing is preferred. The fourth group, the high accessibility and density preference group

(28% of the sample) has a very strong preference for destination accessibility (living close to town and local amenities) and a slight preference for townhouses. While they would also prefer to have a small section, they are most likely to choose high density living within a five minute drive of the CBD.

This research indicates that many more people in Wellington City would like to live in centrally located medium and high density areas than currently live in these types of neighbourhoods. Of those who have a medium to high density preference (60% of the Wellington sample), only 49% currently live in medium and high density areas. This would seem to suggest that there is an unmet demand for high density living in Wellington City. However, preferences for high density in this context can largely be seen as a preference for high destination accessibility, with households willing to live in higher density housing in order to achieve high destination accessibility. 18% of respondents in the medium and high density preference groups lived in a neighbourhood with low destination accessibility and could be said to have a strong level of mismatch with their current neighbourhood. The market appears to favour those with preferences for low density, as they are much more likely to live in their preferred dwelling type and neighbourhood density. 94% of those with a very low density preference lived in a standalone house and 79% living in a low density neighbourhood. Contrary to popular wisdom in New Zealand, this thesis found that the majority (52%) of Wellington City residents value destination accessibility over low density housing features, standalone dwellings and large sections, and are willing to live in medium and high density neighbourhoods in order to have more destination accessibility. This is consistent with other research in New Zealand, which has shown a growing demand for higher density (i.e. medium or high density) housing and destination accessibility (Howden-Chapman et al., 2015; McMurray & Duc, 1977).

Comparing people's preferred method of commuting with their actual method of commuting can shed light on people's ability to achieve their preferences. About twice as many people prefer to walk to work as currently walk to work and about three times as many people prefer to bike to work as currently bike to work (Figure 5.13 in Chapter 5). The ability to use a desired travel mode appears to be related to the neighbourhood that a person lives in. Only 42% of those who live in a low density neighbourhood use their preferred commute mode, while 75% of those who live in a high density neighbourhood use their preferred commute mode. Thus, it seems that travel mode mismatch increases as neighbourhood density decreases. This highlights the importance of a stated preference approach, as revealed preference approaches make it difficult to identify such mismatches.

Chapter 6

Chapter 6 reviewed the current housing market in Wellington City and developed a future growth scenario for 2013 – 2043 based on consumer demand for housing and neighbourhood attributes as revealed in the survey results of Chapter 5. It shed light on both recent housing development patterns in the City and the potential influence of planning, preferences, and affordability on future housing demand trends. While Chapter 5 demonstrated that there is an unmet demand for alternatives to car travel and for compact, accessible neighbourhoods, Chapter 6 demonstrated that the price and attributes of housing are critical to determining whether households choose compact, transit oriented locations over lower density, car oriented neighbourhoods. While there is a substantial minority (about 30%) of the population who prefer highly accessible housing in the central city and are willing to pay a premium for this type of housing, the remainder of the population is more likely to choose between medium and low density housing. While public discourse on the topic often focuses on preferences for density-related attributes (such as dwelling type, outdoor space, and neighbourhood density) as the primary barriers to intensification, this research has indicated that price is the primary barrier to the choice of compact, transit-oriented housing. Because destination accessibility is highly valued, density and price both tend to be higher for dwellings closer to the centre of the City. While higher prices are offset by lower transport costs for one and two bedroom dwellings, the total transport and housing costs of living within five kilometres of the CBD are nevertheless higher than for living in more distant locations for households living in dwellings with three or more bedrooms. This modelled outcome is echoed in revealed housing locations; almost all one and two bedroom dwellings built over the last decade were located within five kilometres of the CBD, whereas the majority of dwellings with three or more bedrooms were built further than five kilometres from the central city. This finding demonstrates that affordability, not merely preferences, is likely to be a driver for many larger households, such as families, to choose lower density, more distant housing. This is consistent with previous research in Wellington, which has shown that higher income individuals are more likely to commute by active transport, likely due to their ability to choose more expensive, accessible neighbourhoods (Mackenbach, Randal, Zhao, & Howden-Chapman, 2016; McKim, 2014).

The chapter also shed light on the influence of planning restrictions on growth patterns by contrasting a ‘top down’ model of residential development, where development patterns are influenced more by local government priorities, and a ‘bottom up’ model, where development patterns are based on consumer preferences, using Wellington City as a case study. When

comparing the planning based scenario and a demand based scenario, the demand based scenario has about 30% less development within the central city and more than double the amount of greenfield development than the planning based scenario. When housing is made more affordable in the demand based scenario, reflecting the hypothetical easing of restrictions in the current District Plan, the demand for low density development on the City periphery decreases and demand for medium density housing in more proximate existing suburbs increases, but demand for high density housing in the central city remains constant. This suggests that price plays a strong role in the choice between medium and low density housing, but not in the choice between medium and high density housing. When examining the relationship between planning rules and housing demand, these findings suggest that the planned amount of high density central city development is somewhat higher than what is demanded given current preferences, prices, and dwelling attributes and that the current restrictions on the development of rural land limit greenfield development considerably. However, this is not necessarily undesirable, as discussed below.

Chapter 7

Chapter 7 used results from Chapter 5 and 6 to investigate the potential impact of the planning and demand based growth scenarios on three outcomes: density, carbon emissions, and affordability in Wellington City. The planning based growth scenario resulted in lower carbon emissions from transport as well as a higher weighted population density by 2043. These outcomes suggest that the City's current planned growth trajectory will assist in achieving the City's goals of reducing carbon emissions and increasing the mode shares for walking and cycling. The planning based growth scenario resulted in higher average rents than the demand based growth scenario, reflecting that demand for locations is highly influenced by price. However, higher rental prices were almost completely offset by lower transport prices, reflecting the fact that the planning based growth scenario sees more people living centrally, where transport costs are lower than in more distant areas.

8.3 Relevance to Policy

A large component of this thesis consisted of investigating preferences towards housing and neighbourhood attributes that are to a greater and lesser extent controlled through the planning process. While it investigates the heterogeneity in these preferences, this thesis is not intended to suggest that urban planning should be driven by an effort to satisfy the current housing and neighbourhood preferences of all households. Instead, it may better serve sustainability and wider

planning objectives to understand how preferences can either hinder or help achieve urban planning goals and other desired outcomes. In the case of Wellington City, goals for transport and land use planning include achieving a compact urban form, a reduction in carbon emissions, and a transport network that prioritises active and public transport over driving. The relevance of this thesis to each of these desired outcomes is discussed briefly.

When comparing Wellington City Council's growth trajectory for the next 30 years with a growth trajectory that is based on consumer demand in the absence of planning restrictions, the City Council's planning based growth trajectory performs better than the demand based scenario, in terms of both carbon emissions and achieving compact development. The planning based growth trajectory results in a higher concentration of growth within five kilometres of the city centre and much less greenfield development, resulting in a city that is much more compact and dense by 2043 than a city without planning restrictions. For dwellings built between 2013 and 2043, transport related carbon emissions are about 20% lower in 2043 in the planning based growth trajectory than a scenario with no planning rules. Given the importance and urgency of reducing carbon emissions, this is an important outcome.

While Wellington City Council has a relatively ambitious target of an 80% reduction in carbon emissions by 2050, the current planned growth scenario is insufficient to achieve an equivalent reduction in the City's emissions from private land transport and results in an increase in emissions due to population growth, despite a reduction in per capita land transport emissions. A substantial reduction in emissions from land transport would require an increase in vehicle fuel efficiency and an increase in active and public transport mode shares, in addition to a compact growth pattern. The planned compact growth trajectory can complement efforts at increasing active and public transport mode shares, as it will see more residents within walking and cycling distance of destinations, and make public transportation more viable by increasing density and the number of residents within walking distance of public transport stops. This study has found that there is an unmet demand for walking and cycling, with more residents currently driving than would prefer to use that travel mode, and more residents preferring to walk and cycle to work than currently use these modes. The ability to use a desired travel mode appears to be related to the neighbourhood in which a person lives, with less than half (42%) of those who live in a very low density neighbourhood using their preferred commute mode, while three quarters of those who live in a high density neighbourhood use their preferred commute mode. Typically, residents would prefer to walk or cycle more than they do. Encouraging compact development can be complementary to efforts to increase walking and cycling.

Planning as a practice was introduced in order to achieve desired environmental and social outcomes. However, planning rules can substantially change the course of residential development and can have unintended consequences. This thesis reviewed the historical origins and the evolving planning approach to minimum parking requirements in Wellington City, as well as consumer demand and willingness to pay for parking. The current minimum parking requirement is one of the oldest and least changed elements of planning in Wellington City. Its origins lie in the early engineering-oriented approach to planning in the City, and it was adopted using guidelines (which have subsequently been criticised for lacking empirical foundations) developed by American engineers. The current District Plan provides a relatively weak justification for the minimum parking requirement, saying that it provides and maintains amenity, access, and safety in suburban areas. When examining the trade-offs that individuals make between the type of dwelling, outdoor space, neighbourhood density, destination accessibility, parking, and price, parking was less important than dwelling type, outdoor space, destination accessibility, and price, but slightly more important than neighbourhood density. On average, respondents were willing to pay \$156 per year for on-street parking, which is slightly higher than the yearly cost for a residential parking permit in Wellington City, \$115 per year²⁵ (Wellington City Council, 2014). 26% of the sample were not willing to pay considerably more for off-street parking as compared to on-street parking. The remaining 74% of the sample were willing to pay between \$12 and \$21 per week for off-street parking, which will be less than the cost of providing off-street parking in many cases. A minimum parking requirement increases the cost of housing, reduces density, and encourages car travel, effects that seem to run against the City's goals of achieving a compact, low carbon city (Manville, 2013; McDonnell, Madar, & Been, 2011; Shoup, 2005). The minimum parking requirement lacks a justification that outweighs its negative impacts on the City's desired outcomes.

While planning policy can enable development to take place in certain areas, it cannot force private development to take place in these areas. In this regard, the achievement of Council goals through the distribution of private residential development is reliant on demand for housing in certain areas. While the findings in this study suggest that the Council-planned amount of high density central city development is somewhat higher than what is demanded given current preferences and prices, preferences for compact development have been increasing substantially over the past three decades, and are likely to continue to increase. The study found that there is a considerable unmet demand for medium density, accessible housing, but that affordability is a barrier for households to choose this type of housing. At the same time, current planning rules severely restrict infill

²⁵ Residential parking permits are required in 8 suburbs, and payment for on-street parking is not required in the majority of suburbs.

development in most existing neighbourhoods, which decreases the availability of accessible medium density neighbourhoods and likely increases the cost of this type of housing. This thesis explored how greater affordability would influence dwelling choices, and the results imply that efforts to make housing within five kilometres of the city more affordable would enable more households to live centrally. This is an outcome that would, as well as reducing total housing and transport costs, better satisfy preferences, and result in positive environmental outcomes. While the current planned growth scenario for the City generally has positive outcomes, it is desirable to ensure that this growth scenario is able to be achieved under the current planning regime and market demand.

8.4 Reflections on methodology and directions for future research

Housing, neighbourhood, and accessibility preferences are a contentious issue in New Zealand and preferences for these variables vary greatly across geographic space and by socio-demographics, such as age, income, and household type. A major weakness of much of the previous research on housing and neighbourhood preferences in New Zealand is that it has not been representative of the population of interest (the population of cities and regions) in terms of socio-demographics or geographic distribution. Problems with previous research on the subject include: small sample sizes, non-random sampling through social networks, low response rates, and severe under-sampling of minority groups, lower income individuals, and younger individuals (Haarhoff et al., 2012; Ivory, Burton, & Harding, 2013; Yeoman & Akehurst, 2015). A strong point of the current study is that it used a randomised sampling technique intended to capture a sample that was demographically and geographically representative of Wellington City and critically analysed the impact of recruitment and completion mode on results. The survey had a relatively high response rate (33%), and while it under-represented the lowest income bracket and the elderly, it was much more demographically representative than previous studies on the subject. However, the study is intended to be representative of Wellington City, and not the wider region or the country as a whole. Housing, neighbourhood, and accessibility preferences are likely to vary across cities and regions, due to variations in income, urban form, as well as the tendency of households to select urban areas that align with their preferences. As Wellington City is the most compact and least car-oriented city in New Zealand, it would be expected that the City would have a larger percentage of the population preferring compact development and alternatives to car travel than in the wider Wellington region or in New Zealand as a whole.

The current study surveyed individuals as a means of assessing preferences for housing, neighbourhood, and destination accessibility, and assumed that individuals' preferences would accurately represent household preferences and location choices. In reality, household location choice decisions are most often made by multiple members of a household, with choices made being the result of compromises made between multiple household members' preferences (Molin, Oppewal, & Timmermans, 1999). This is a limitation of the current study, and future research into the impact of joint decision-making on location and dwelling choice would be valuable.

When respondents complete discrete choice experiments, they adopt decision-making strategies to simplify the choice process. One of many possible strategies is to ignore a specific attribute, referred to as attribute non-attendance in the literature (Hensher et al., 2011; Scarpa et al., 2010). In the current study, the low density preference group was equally likely to choose a dwelling at each of the four price levels used in the study. This suggests that they did not attend to the price attribute when choosing dwellings in the choice experiment. This is problematic as it results in unrealistically high willingness to pay values. One possible explanation is that some respondents could not afford any of the choices, and thus chose to ignore the price attribute when choosing an option. However, the low density preference group had much higher incomes than other preference groups that were much more sensitive to price. Another possibility is that this group could afford all of the price levels. This is unlikely as the highest price level would require the average respondent in the class group to spend 48% of their income on housing. Future research in this area could take steps to increase the likelihood that the price attribute is attended to, such as displaying the attribute more prominently or expressing prices as a percentage of current housing costs.

Due to the quantitative nature of the study and the necessity of limiting the time and complexity of the survey, the study took a relatively simplistic view of preferences for housing, neighbourhood, and accessibility attributes. It measured preferences for six housing and neighbourhood attributes: dwelling type, outdoor space, neighbourhood density, destination accessibility, parking, and dwelling price, assuming that all other attributes were equal. However, in reality, attributes such as dwelling age, architectural style, warmth and dryness, and build quality also vary among dwellings and between neighbourhoods of varying densities. These and other factors, such as the availability of public outdoor space, body corporate fees and rules, and noise likely influence the likelihood of households to choose medium and high density housing. Future research could employ a different research method, such as in-depth interviews, to shed light on

the complex way a multitude of factors influence the potential for compact development to accommodate population growth in New Zealand cities.

This research was primarily focused on preferences for and trade-offs among housing type, neighbourhood type, and transport accessibility when choosing where to live. A notable outcome of this research is that, at least in the case of Wellington City, there is a substantial unrealised preference for alternatives to car travel, even among individuals who do not prioritise destination accessibility in their choice of residential location. This indicates that many individuals living in low density, car-oriented neighbourhoods may live there in spite of, rather than because of, their transport mode and destination accessibility preferences. Future research could investigate the relationship between travel preference and residential location choice, and the barriers to walking, cycling, and public transport among those who currently drive but would prefer to use alternatives to driving.

The current study viewed the Wellington housing market as ‘closed’, assuming that there was a set amount of future population growth and that the type and location of housing available did not influence the level of population growth. Previous international research has indicated that planning rules influence the location of housing development, and that stringent controls in one district often result in spill-over into other area, thus increasing sprawling or leapfrog development (Byun & Esparza, 2005; Zellner et al., 2010). Future research into this topic in New Zealand would be valuable, as it could shed light on the relative benefits of planning at a local or regional level.

This study investigated the transport-related carbon emissions of residents living in different neighbourhoods throughout Wellington City and found that residents of high density, central city neighbourhoods had much lower carbon emissions from transport than residents of low density neighbourhoods on the city fringe. While land transport constitutes a large fraction (36%) of carbon emissions in Wellington City, stationary energy use and aviation together constitute the majority of Wellington City’s emissions (38% and 19% of emissions, respectively) (URS New Zealand Limited, 2014). Previous international research has indicated that residents of compact neighbourhoods also have lower household energy use than residents of dispersed neighbourhoods, and that emissions from consumption (other than transport and energy consumption) and air travel can offset efficiency gains from low household energy and land transport emissions (R. Ewing & Rong, 2008; Heinonen & Junnila, 2011). Future research could add to knowledge by investigating the relative emissions from household energy use and consumption of residents living in different household and neighbourhood types. This would be significant as it can assist cities in reaching their carbon emissions reduction goals.

8.5 Conclusion

While there has already been a large amount of research on housing, neighbourhood, and transport preferences, this thesis adds to the literature in four key ways. Firstly, it puts the study of housing and transport preferences in the context of local land use rules, policies, and strategies. This is a useful approach as it ensures that research is both policy-oriented and allows researchers to understand the extent to which development patterns and environmental outcomes are driven by market forces (including preferences) and/or planning. Research on preferences can be greatly informed by understanding the extent to which planning rules and other factors limit the ability of actors to achieve their preferences in the marketplace. Additionally, this approach allows research to be more policy-relevant. In this way this thesis has attempted to bridge the gap that frequently exists between research within the economic, environmental, and planning fields, as well as the gap between researchers and policy-makers to whom research is relevant.

Secondly, this thesis has made a contribution in relation to the understanding of data collection techniques. It investigated the relative merits of internet and door to door survey recruitment and completion modes while holding survey presentation mode constant. The impact of survey design on results is an important issue for researchers, who face both changing survey technologies and declining survey response rates.

Thirdly, this thesis has contributed to an understanding of the complex relationships between housing and neighbourhood preferences and accessibility preferences. This is significant as these preferences are often assumed to be synonymous, which has implications for both the calculation of environmental benefits from compact development and the provision of transport infrastructure in differing neighbourhood types. This study has been able to disentangle these differing preferences, providing a richer picture of urban residents' trade-offs.

Lastly, this thesis has shed light on the ability of compact development to accommodate population growth in New Zealand cities and reduce their carbon emissions, issues that are increasingly critical as New Zealand cities address the need to improve their environmental sustainability while also improving the lived experience of their residents.

8.5 Conclusion

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APPENDICES

APPENDIX A: Human ethics approval

Phone 0-4-463 5400

Email susan.corbett@vuw.ac.nz

MEMORANDUM

TO	Nadine Dodge
COPY TO	Ralph Chapman
FROM	AProf Susan Corbett, Convener, Human Ethics Committee
DATE	10 November 2015
PAGES	1
SUBJECT	Ethics Approval: 20392 Benefits of Alternative Development Patterns - Wellington

Thank you for your request to amend and extend your ethics approval. This has now been considered and the request granted. Your application has approval until 10 February 2016.

If your data collection is not completed by this date you should apply to the Human Ethics Committee for an extension to this approval.

Best wishes with the research.

Kind regards

Susan Corbett

Convener, Victoria University Human Ethics Committee

APPENDIX B: Survey questionnaire

Welcome to the 2014 Wellington Housing Preference Survey!

Wellington City Council has partnered with the Victoria University of Wellington, which is conducting an independent study on housing preferences in the City.

The survey involves a series of tick boxes and should only take about 15 minutes to complete.

Why is this survey important?

The survey is aimed at discovering what trade-offs people make between different housing and neighbourhood attributes and how these attributes contribute to housing and neighbourhood satisfaction. The study will also help us understand what trade-offs Wellington households are willing to make to live in their preferred neighbourhood or housing type. For instance, will a household accept a smaller dwelling (like a townhouse or apartment) to live in their preferred location?

How will the information be used?

The information from this survey will be used for research purposes by the Victoria University of Wellington. The research will be available in the Victoria University Library and may also be published in academic journals.

This study will be used by planners at Wellington City Council charged with developing the new 'Spatial Plan' - a 10-year vision for growth and change in Wellington.

How are responses kept confidential?

This research has been approved by the Victoria University of Wellington human ethics committee. Participation is entirely voluntary. All responses provided are **confidential** – names will not be recorded and your responses will in no way be attributable to you. Only aggregated details from the survey will be published in the final report.

If you have any further questions or would like to receive further information about the project, please contact PhD candidate Nadine Dodge at 022 173 1056 dodgenadi@myvuw.ac.nz or Associate Professor Ralph Chapman, at the School of Geography Environment and Earth Sciences at Victoria University 04 463 6153 ralph.chapman@vuw.ac.nz.

Let's get started!

Thanks in advance for your participation in the Wellington Housing Survey.

At the end of the survey you will have the chance to enter win a **\$100 VISA Prezzy Card**.

Please click the button below to begin.

0% 100%

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**Think back to when you first chose to move to your existing house/flat.
 What factors were important in determining your choice?**

	Not at all important	Somewhat important	Important	Very Important	Extremely Important
Had a convenient commute via motor vehicle	☐	☐	☐	☐	☐
Had a convenient commute via bus, train, or ferry	☐	☐	☐	☐	☐
Had a convenient commute via walk or cycle	☐	☐	☐	☐	☐
Was walking distance to outdoor space, such as parks	☐	☐	☐	☐	☐
Was walking distance to local amenities, such as shops	☐	☐	☐	☐	☐
Was near family/friends	☐	☐	☐	☐	☐
Was in a safe neighbourhood	☐	☐	☐	☐	☐
Was in a visually attractive neighbourhood	☐	☐	☐	☐	☐
Was convenient to desirable schools	☐	☐	☐	☐	☐
Was affordable	☐	☐	☐	☐	☐
Was warm and dry	☐	☐	☐	☐	☐
Had a private outdoor space, such as backyard or porch	☐	☐	☐	☐	☐
Had architectural features, such as style, age, or colour	☐	☐	☐	☐	☐
Was a standalone home	☐	☐	☐	☐	☐
Had a private parking space	☐	☐	☐	☐	☐
Was on a quiet street	☐	☐	☐	☐	☐

0% 100%

>>

How likely are you to move house within the next 2 years?

- ☐ Not at all likely
- ☐ Somewhat likely
- ☐ Very likely
- ☐ Undecided

If you did move house, what size dwelling would you likely move to?

- ☐ 1 bedroom
- ☐ 2 bedroom
- ☐ 3 bedroom
- ☐ 4 or more bedrooms

0% 100%

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[Displayed if respondent indicated they would likely move to a 2 bedroom dwelling. Different prices are displayed for 1 ,2 ,3 , and 4 bedrooms]

Now, imagine that you are looking for a new place to live that has 2 bedrooms. The following are hypothetical 2 bedroom homes in Wellington City.

Homes are available to rent or to own, and prices are expressed in market rent per week.*

Keep in mind anything not referred to in the question, such as warmth, appliances, square footage, school quality, and safety, is exactly the same between the options presented.

The pictures included with each question are to indicate the type of housing, and are examples only.

For each scenario, choose the option that best reflects your preferences. The choices presented may not seem ideal to you, but you should indicate your preferred choice in each case anyway.

* Market rent is defined as what a willing landlord might reasonably expect to receive, and a willing tenant might reasonably expect to pay for a tenancy.

0%100%

>>

1 of 12

	Standalone house	Townhouse	Standalone house

Outdoor space	Porch / balcony	Small section	Large section
Destinations	30 min walk to local towncentre 30 min drive to CBD 60 min bus to CBD	5 min walk to local towncentre 10 minute drive to CBD 15 minute bus to CBD	10 min walk to local towncentre 15 min drive to CBD 30 min bus to CBD
Dwellings in Neighbourhood	Mix of apartments / townhouses and standalone houses	Primarily apartments/townhouses	Primarily standalone houses
Parking	Off street	Off street	On street
Market rent	\$ 300 per week	\$ 500 per week	\$ 300 per week

0%100%

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2 of 12

	Townhouse	Apartment	Townhouse

Outdoor space	Porch / balcony	Large section	Small section
Destinations	10 min walk to local towncentre 15 min drive to CBD 30 min bus to CBD	5 min walk to local towncentre 5 min drive to CBD 15 min bus to CBD	30 min walk to local towncentre 30 minute drive to CBD 60 minute bus to CBD
Dwellings in Neighbourhood	Mix of apartments / townhouses and standalone houses	Primarily apartments/townhouses	Primarily standalone houses
Parking	None	Off street	On street
Market rent	\$ 300 per week	\$ 500 per week	\$ 400 per week

0% 100%

>>

3 of 12

	Townhouse	Townhouse	Standalone house

Outdoor space	Porch / balcony	None	Small section
Destinations	10 min walk to local towncentre 15 min drive to CBD 30 min bus to CBD	30 min walk to local towncentre 30 min drive to CBD 60 min bus to CBD	5 min walk to local towncentre 5 minute drive to CBD 15 minute bus to CBD
Dwellings in Neighbourhood	Primarily apartments/townhouses	Mix of apartments / townhouses and standalone houses	Primarily standalone houses
Parking	Off street	Off street	None (available for purchase)
Market rent	\$ 400 per week	\$ 300 per week	\$ 600 per week

0% 100%

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4 of 12

	Townhouse	Apartment	Apartment

Outdoor space	None	Porch / balcony	None
Destinations	5 min walk to local towncentre 5 min drive to CBD 15 min bus to CBD	5 min walk to local towncentre 5 minute drive to CBD 15 minute bus to CBD	10 min walk to local town centre 15 min drive to CBD 30 min bus to CBD
Dwellings in Neighbourhood	Mix of apartments / townhouses and standalone houses	Primarily apartments / townhouses	Mix of apartments / townhouses and standalone houses
Parking	Off street	On street	Off street
Market rent	\$ 400 per week	\$ 500 per week	\$ 600 per week

0% 100%

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5 of 12

	Standalone house	Townhouse	Townhouse

Outdoor space	Small section	Large section	Large section
Destinations	10 min walk to local towncentre 15 min drive to CBD 30 min bus to CBD	30 min walk to local towncentre 30 minute drive to CBD 60 minute bus to CBD	5 min walk to local towncentre 5 min drive to CBD 15 min bus to CBD
Dwellings in Neighbourhood	Mix of apartments / townhouses and standalone houses	Mix of apartments / townhouses and standalone houses	Primarily standalone houses
Parking	Off street	Off street	On street
Market rent	\$ 400 per week	\$ 300 per week	\$ 600 per week

0% 100%

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6 of 12

	Apartment	Apartment	Standalone house

Outdoor space	Porch / balcony	Small section	Large section
Destinations	5 min walk to local towncentre 5 min drive to CBD 15 min bus to CBD	10 min walk to local towncentre 15 minute drive to CBD 30 minute bus to CBD	10 min walk to local towncentre 15 min drive to CBD 30 min bus to CBD
Dwellings in Neighbourhood	Primarily apartments / townhouses	Mix of apartments / townhouses and standalone houses	Primarily apartments / townhouses
Parking	Off street	On street	Off street
Market rent	\$ 600 per week	\$ 500 per week	\$ 300 per week

0% 100%

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7 of 12

	Townhouse	Apartment	Standalone house

Outdoor space	None	Large section	Porch / balcony
Destinations	10 min walk to local town centre 15 min drive to CBD 30 min bus to CBD	10 min walk to local towncentre 15 min drive to CBD 30 min bus to CBD	5 min walk to local town centre 5 minute drive to CBD 15 minute bus to CBD
Dwellings in Neighbourhood	Primarily apartments / townhouses	Primarily apartments/townhouses	Mix of apartments / townhouses and standalone houses
Parking	Off street	None (available for purchase)	Off street
Market rent	\$ 500 per week	\$ 500 per week	\$ 300 per week

0% 100%

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8 of 12

	Apartment	Townhouse	Standalone house

Outdoor space	Large section	Small section	Small section
Destinations	5 min walk to local towncentre 5 min drive to CBD 15 min bus to CBD	10 min walk to local towncentre 15 minute drive to CBD 30 minute bus to CBD	30 min walk to local towncentre 30 min drive to CBD 60 min bus to CBD
Dwellings in Neighbourhood	Primarily apartments/townhouses	Primarily standalone houses	Mix of apartments / townhouses and standalone houses
Parking	Off street	On street	On street
Market rent	\$ 600 per week	\$ 400 per week	\$ 300 per week

0% 100%

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9 of 12

	Apartment	Townhouse	Standalone house

Outdoor space	None	Porch / balcony	Small section
Destinations	10 min walk to local town centre 15 min drive to CBD 30 min bus to CBD	5 min walk to local towncentre 5 minute drive to CBD 15 minute bus to CBD	30 min walk to local towncentre 30 min drive to CBD 60 min bus to CBD
Dwellings in Neighbourhood	Primarily apartments/townhouses	Mix of apartments / townhouses and standalone houses	Primarily standalone houses
Parking	On street	None (available for purchase)	On street
Market rent	\$ 600 per week	\$ 400 per week	\$ 300 per week

0% 100%

>>

10 of 12

	Townhouse	Apartment	Standalone house

Outdoor space	None	Large section	Small section
Destinations	10 min walk to local towncentre 15 min drive to CBD 30 min bus to CBD	30 min walk to local town centre 30 min drive to CBD 60 min bus to CBD	10 min walk to local towncentre 15 minute drive to CBD 30 minute bus to CBD
Dwellings in Neighbourhood	Primarily apartments/townhouses	Mix of apartments / townhouses and standalone houses	Primarily standalone houses
Parking	None (available for purchase)	Off street	None (available for purchase)
Market rent	\$ 400 per week	\$ 400 per week	\$ 300 per week

0% 100%

>>

11 of 12

	Apartment	Townhouse	Townhouse

Outdoor space	Small section	Porch / balcony	None
Destinations	10 min walk to local towncentre 15 min drive to CBD 30 min bus to CBD	5 min walk to local towncentre 5 minute drive to CBD 15 minute bus to CBD	5 min walk to local town centre 5 min drive to CBD 15 min bus to CBD
Dwellings in Neighbourhood	Primarily apartments/townhouses	Mix of apartments / townhouses and standalone houses	Primarily apartments/townhouses
Parking	Off street	None (available for purchase)	On street
Market rent	\$ 600 per week	\$ 500 per week	\$ 400 per week

0% 100%

>>

12 of 12

	Standalone house	Townhouse	Apartment

Outdoor space	Large section	Small section	None
Destinations	5 min walk to local town centre 5 min drive to CBD 15 min bus to CBD	5 min walk to local towncentre 5 minute drive to CBD 15 minute bus to CBD	10 min walk to local town centre 15 min drive to CBD 30 min bus to CBD
Dwellings in Neighbourhood	Primarily standalone houses	Primarily apartments/townhouses	Mix of apartments / townhouses and standalone houses
Parking	None (available for purchase)	None (available for purchase)	Off street
Market rent	\$ 600 per week	\$ 500 per week	\$ 400 per week

0% 100%

>>

Are you?

- ☐ Male
☐ Female
☐ Other

Are you?

- ☐ 18 - 24 yrs
☐ 25 - 34 yrs
☐ 35 - 49 yrs
☐ 50 - 59 yrs
☐ 60 - 69 yrs
☐ 70 - 84 yrs
☐ 85 or more years

0% 100%

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Please indicate your gross individual income per year (before tax):

- ☐ \$20,000 or less
- ☐ \$20,001 - \$30,000
- ☐ \$30,001 - \$40,000
- ☐ \$40,001 - \$50,000
- ☐ \$50,001 - \$60,000
- ☐ \$60,001 - \$70,000
- ☐ \$70,001 - \$100,000
- ☐ \$100,001 - \$150,000
- ☐ \$150,000 or more

Which best describes you?

- ☐ Looking for work/unemployed
- ☐ Looking after home/family
- ☐ Working full time (30+ hours per week)
- ☐ Working part time (less than 30 hours per week)
- ☐ Full-time student
- ☐ Part-time student
- ☐ Retired
- ☐ Beneficiary
- ☐ Other

0% 100%

>>

[Displayed if respondent is working or studying]

TE WHARE WĀNANGA O TE ŪPOKO O TE IKA A MĀUI
VICTORIA
UNIVERSITY OF WELLINGTON

Which transport option would you prefer to use most for your daily transport needs (in an ideal world)?

- ☐ Ideally, I would **drive** to the places I need to go.
- ☐ Ideally, I would **bike** to the places I need to go.
- ☐ Ideally, I would **walk or jog** to the places I need to go.
- ☐ Ideally, I would take **public transport** to the places I need to go.

0% 100%

>>

[Displayed if respondent is not working or studying]

TE WHARE WĀNANGA O TE ŪPOKO O TE IKA A MĀUI
VICTORIA
UNIVERSITY OF WELLINGTON

Which transport option would you prefer to use most for your commute (in an ideal world)?

- ☐ Ideally, I would **drive** to work.
- ☐ Ideally, I would **bike** to work.
- ☐ Ideally, I would **walk or jog** to work.
- ☐ Ideally, I would take **public transport** to work.

0% 100%

>>

Which best describes your current household?

- ☐ Couple living alone
- ☐ Couple living with other adults
- ☐ Couple or extended family living with children, some aged 0-17 years
- ☐ Single adult living with children, some aged 0-17 years
- ☐ Family living with children, all aged 18 years or older
- ☐ Adult living alone
- ☐ Adult living with other adults
- ☐ Living with parents/guardian
- ☐ Other

Including yourself, how many people in your household are aged 18 years or older?

Please do not include anyone who usually lives somewhere else or is just visiting

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5 or more people

0% 100%

>>

What type of dwelling do you live in now?

- ☐ Standalone house on separate lot
- ☐ Semi-detached house or townhouse
- ☐ Low-rise apartment complex (three levels or less)
- ☐ Multi-level apartment complex (four or more levels)
- ☐ Standalone house split into two or more flats

0% 100%

>>

Which best describes your current house/flat?

- ☐ Rented (owned by a private person, trust or business)
- ☐ Rented (owned by state-owned corporation or government department/ministry)
- ☐ Owned by myself or someone else who lives here (with or without a mortgage)
- ☐ Other

On average, how much does your household spend per week on rent or home ownership costs for the household?

Home ownership costs include mortgage payments, rent, rates, dwelling insurance and maintenance related to your own household.

- ☐ Less than \$200 per week
- ☐ \$200 - \$299 per week
- ☐ \$300 - \$399 per week
- ☐ \$400 - \$499 per week
- ☐ \$500 - \$599 per week
- ☐ \$600 - \$699 per week
- ☐ \$700 - \$799 per week
- ☐ \$800 - \$899 per week
- ☐ \$900 - \$999 per week
- ☐ \$1,000 per week or more

0% 100%

>>

How many motor vehicles are normally available for use by people in your household?

- ☐ 0
- ☐ 1
- ☐ 2
- ☐ 3 or more

How long have you lived at your current residence?

- ☐ Less than 1 year
- ☐ 1 - 5 years
- ☐ More than 5 years

0% 100%

>>

[Displayed if respondent is working part-time or full-time]

In the last 7 days, how often did you use each of the following travel methods to commute to work?

	5 - 7 days	3 - 4 days	1 - 2 days	Not at all
Walking or jogging	☐	☐	☐	☐
Cycling	☐	☐	☐	☐
Public transport (bus, train, ferry)	☐	☐	☐	☐
Driving a passenger motor vehicle (car, truck, van)	☐	☐	☐	☐
Passenger in a motor vehicle	☐	☐	☐	☐
Driving a motorcycle or motor scooter	☐	☐	☐	☐
Worked at home	☐	☐	☐	☐
Other	☐	☐	☐	☐

0% 100%

>>

[Displayed if respondent is studying part-time or full-time]

In the last 7 days, how often did you use each of the following travel methods to commute to your study?

	5 - 7 days	3 - 4 days	1 - 2 days	Not at all
Walking or jogging	☐	☐	☐	☐
Cycling	☐	☐	☐	☐
Public transport (bus, train, ferry)	☐	☐	☐	☐
Driving a passenger motor vehicle (car, truck, van)	☐	☐	☐	☐
Passenger in a motor vehicle	☐	☐	☐	☐
Driving a motorcycle or motor scooter	☐	☐	☐	☐
Worked at home	☐	☐	☐	☐
Other	☐	☐	☐	☐

0% 100%

>>

[Displayed if respondent is recruited from email panel]

TE WHARE WĀNANGA O TE ŪPOKO O TE IKA A MĀUI
VICTORIA
 UNIVERSITY OF WELLINGTON

What suburb do you live in?

0% 100%

[Displayed if respondent is working part-time or full-time]

Where do you work?

A map of the Wellington region divided into ten colored areas representing different work regions. The regions are: Kapiti (yellow), Porirua (light blue), Upper Hutt (pink), Lower Hutt (red), Wairarapa (light green), Eastern Suburbs (purple), Central City (dark blue), Northern Suburbs (orange), Western Suburbs (light green), and Southern Suburbs (dark blue). A legend at the bottom shows a color scale from 0% to 100%.

[Displayed if respondent is studying part-time or full-time]

Where do you study?

A map of the Wellington region divided into ten colored areas representing different study locations. The areas are: KAPITI (yellow), PORIRUA (light blue), UPPER HUTT (pink), NORTHERN SUBURBS (orange), WESTERN SUBURBS (light green), CENTRAL CITY (light blue), EASTERN SUBURBS (purple), LOWER HUTT (pink), SOUTHERN SUBURBS (dark blue), and WAIRARAPA (light green). The map is surrounded by a blue border representing the sea. Below the map is a legend bar with a green square and a white square, labeled '0%' and '100%' respectively. A navigation button with '>>' is located in the bottom right corner.

How do you feel about where you are currently living?

- ☐ Very satisfied
- ☐ Satisfied
- ☐ Somewhat satisfied
- ☐ No feeling either way
- ☐ Dissatisfied
- ☐ Very dissatisfied
- ☐ Don't know

Think about your house/flat. Are any of these things major problems for you?

You can check as many as you wish

- ☐ It's too small
- ☐ It's hard to get to from the street
- ☐ It's in poor condition
- ☐ It's damp
- ☐ It's too cold or difficult to heat/keep warm
- ☐ There are pests such as mice or insects
- ☐ It's too expensive
- ☐ Other major problems
- ☐ No major problems

Think about your neighbourhood. Are any of these things major problems for you?

You can check as many as you wish

- ☐ It's too far from work
- ☐ It's too far from other things I want to get to
- ☐ It's not safe
- ☐ It doesn't have adequate public transport service
- ☐ It doesn't have adequate sidewalks, cycle lanes, and/or pedestrian crossings
- ☐ Noise or vibration
- ☐ Air pollution from traffic fumes, industry, or other smoke
- ☐ Problem neighbours
- ☐ Graffiti, litter, and/or rubbish
- ☐ Barking dogs
- ☐ Other major problems
- ☐ No major problems

0% 100%

>>

Thank you for completing the 2014 Wellington Housing Preference Survey!

-
- ☐ Yes, enter me to win a \$100 VISA Prezzy card.
- ☐ Yes, I would like to receive a summary of the results once the study has finished.

The best way to contact me is via:

If you have any further questions or would like to receive further information about the project, please contact PhD candidate Nadine Dodge at 022 173 1056 dodgenadi@myvuw.ac.nz or Associate Professor Ralph Chapman, at the School of Geography Environment and Earth Sciences at Victoria University 04 463 6153 or 021 725 742 ralph.chapman@vuw.ac.nz.

0% 100%

APPENDIX C: Door to door survey neighbourhoods

Seatoun/Strathmore – Very low density

Crofton Downs – Very low density

Happy Valley/Island Bay – Very low density

Churton Park – Very low density

Northland – Low density

Hataitai – Low density

Johnsonville – Low density

Aro Valley – Medium density

Newtown – Medium density

Mt Victoria – High density

Te Aro/Terrace – High density

(Google, 2015)

APPENDIX D: Wellington City neighbourhoods

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