Commuting in Wellington: a geographic econometric analysis of commute mode, residential location and car ownership

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1.0 INTRODUCTION

Infrastructure underpins modern cities: connecting people to amenities, education and employment. Understanding how this works is the domain of transportation modelling, a discipline that has been underutilized in New Zealand. Interpreting travel patterns and household/individual behaviour at the micro level has important implications for economic growth and quality of life.

The transportation modelling literature has provided frameworks for analysing decisions about where to live, how to get to work and how many cars to own (Bhat and Guo, 2007; Cao, Mokhtarian and Handy, 2007; Salon, 2009; Matas and Raymond, 2008). Studies of such decisions usually draw on discrete choice models (McFadden, 1978; Bhat, 2000; Train, 2009) and assume that people, in deciding where to live, are concerned about neighbourhood characteristics and time taken to get to work. Figure 1 displays a typical situation, where an individual must decide which location to live in. Further, conditional upon having chosen a home location, the individual must choose how many cars to own and how to get to work. A standard trade-off is between relatively expensive housing close to downtown, which affords a cheaper commute (in both time and monetary terms), versus cheaper housing further from downtown. When comparing commuting strategies, the individual may trade off expenses (driving generally being more expensive than walking/cycling or using public transport) against time taken. To implement a discrete choice model, it is important to evaluate alternatives available to the individual that are not observed in the data, since these facilitate the researcher's understanding of why an individual made the choice actually observed. Evaluating possible commute times for individuals who could potentially live in many locations and employ many commute modes is computationally expensive. Studies generally rely upon level of service (LOS) surveys provided by civic authorities (Bhat and Guo, 2007) or very sparse random sampling of potential locations (Salon, 2009) to minimise computational cost.

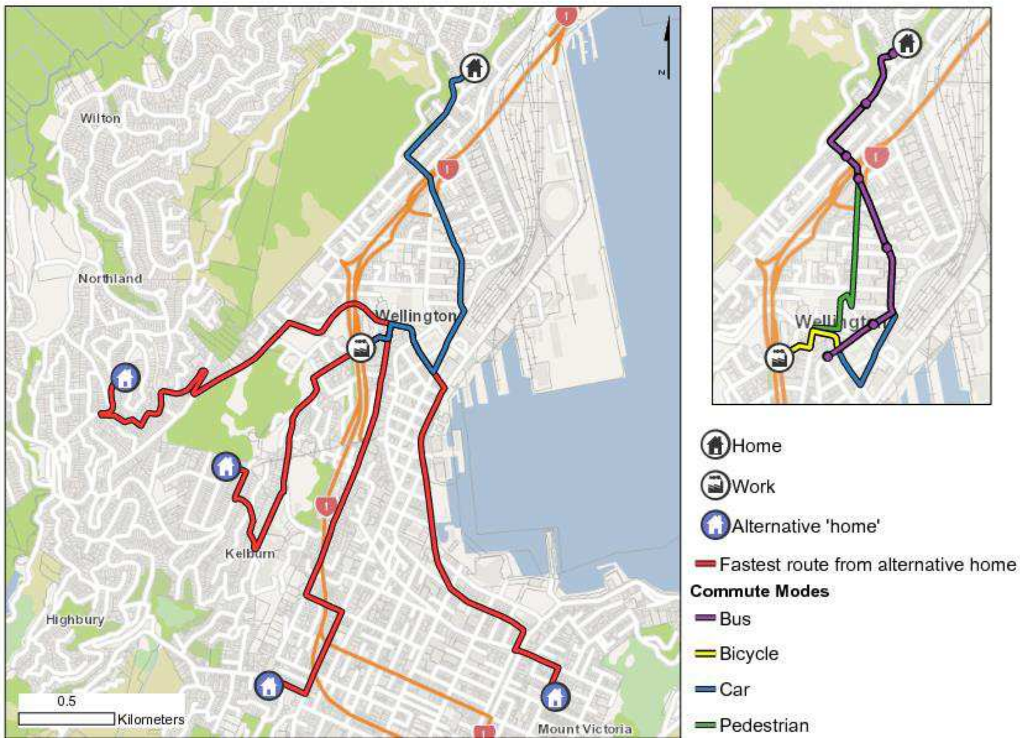

Figure 1: A sample of alternative home locations with the fastest commute route. Inset shows the fastest routes possible using alternative commute modes.

This paper describes an ongoing geography and economics interdisciplinary study which explores the decisions of where to live, how to get to work and how many cars to own using NZ Household Travel Survey (HTS) data for Wellington. With this survey, we can quantify the factors that influence these decisions. By sampling a greater number of potential home locations (200 alternatives per individual commuter), this study will more accurately model residential choices and allow us to assess the effect of geographically varying neighbourhood characteristics. Through a more realistic route network, we also improve the modelling of commuting alternatives.

2.0 NETWORK ANALYSIS

Geographic Information Systems (GIS) have an important role to play in this area of econometric enquiry. The authors created an accurate network of the Greater Wellington Region's road, pedestrian and public transport routes. This network can model the different commuting choices for drivers, cyclists, pedestrians, and public transport users in both time and monetary costs.

The HTS currently provides travel information on 25,000 individuals in 10,200 households nationwide, gathered since 2003. Survey participants record demographic information and log all their travel for two consecutive days. By data mining this travel log, we can categorise workers according to how they commute, and analyse this in relation to their home and work locations and the number of vehicles they own. By calculating the costs of the real and alternative commutes, we can estimate why people make the choices they do (residential location, commute mode and car ownership levels) and do not choose the alternatives.

To provide these costs, we calculate walking, cycling, public transport and driving commutes for the HTS commuters within the Greater Wellington Region from actual and simulated home locations to their work location (Figure 1). The routes will record time taken, distance and cost. For the Greater Wellington Region, this comprises of over 1,000,000 potential commuting routes. Processing these routes is highly computationally intensive and will be conducted using ArcGIS software over the university's Condor distributed computing system.

The route network was largely constructed from publicly available data from a variety of sources. In modelling hypothetical commuting choices, the network can account for a variety of characteristics of any route. Three such characteristics are noted here. First, the average speed of cyclists and pedestrians is influenced by hill slope, with a downhill incline providing for increased average speed up to a certain slope angle. Conversely, travelling uphill is always harder than on the flat. Second, when solving for the shortest possible route between places via public transport, restrictions were noted for 'premium' public transport services. An example of this distinction would be comparing the Airport Flyer (a relatively more expensive airport shuttle that stops in residential and commercial areas) to a cheaper passenger train. The model can use this information to restrict or allow such 'premium' services and quantify the marginal costs and benefits in terms of both time and money. Third, it is possible to specify a time penalty to represent waiting for (or transferring between) public transport services. This can be a static number (five minutes for all modes), varied by mode (five minutes for buses, seven for trains), or based on a function (very small for high-frequency, never-late services; very high for those that are low-frequency and unreliable). Quantifying this last parameter is a current goal of the project, dependent on securing suitable data related to service punctuality.

3.0 CONCLUSIONS

The HTS data allows us to categorise households according to how they commute, and analyse this in relation to their home and work locations, and the number of vehicles they own. We have modelled where the HTS participants actually live and plan to extend this to account for alternative locations of where they could live.

The GIS modelling in this project underpins econometric modelling of important household decisions and the project is ongoing. We have created the network dataset and calculated routes across four different commute modes (driving, public transport, walking and cycling) from the real home location to the participants work location. This modelling will be extended to alternative home locations. Potentially the econometric analysis of the GIS data created could allow us to explore many interesting hypotheses:

1. To what extent do school zones and local school performance influence property prices and residential decisions?
2. Do residential and commuting preferences differ significantly between rural and urban areas?
3. How does accessibility to the road and public transport networks affect house prices?

The interdisciplinary study has the potential to contribute to a number of important policy areas within New Zealand. Local governments control the provision and reliability of public transport, the layout of parks and recreational spaces, and also the growth of cities through the Resource Management Act. All these policies have potential impacts on people's decisions over where to live and how to commute (Cao, Mokhtarian and Handy, 2007). For optimal road development, emissions control, and managing New Zealand's exposure to oil price shocks, it is important for central government to know the effect of changing costs of commuting (both in terms of time and dollar values) on the use of vehicles (Donovan et al., 2008; Kennedy and Wallis, 2007).

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