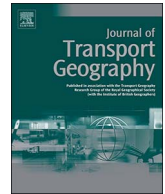




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Watching the clock on the way to work? Analysing trends in commuting activities, modes and gender differences in commute times, using hazard-based duration modelling methods

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ABSTRACT

This study uses Hazard-based duration modelling methods to investigate commute patterns of males and females, with the aim of exploring the variability of commute times and modes over a period of nine years beginning in 2003. Securing two major datasets of the UK National Travel Survey (NTS) and Tyne and Wear household travel survey, as well as the level of detail that the chosen datasets offer, made it possible to ascertain the complexity of commuter travel at its fundamental level. Duration models have been very popular when analysing duration related activities. However, duration modelling research in the context of transport so far has been restricted to cross sectional one-off datasets. This is the first study that investigates commuting durations at a disaggregate level over a sustained period of nine years using duration modelling methods to acquire a fundamental understanding of the changes in commute durations. Gender aspects as well as the transport modes, including non-motorised transport (NMT), car and public transport (PT), were also addressed in the analysis. Probability density functions (PDFs), survival functions (S(f)) and hazard functions (H(f)) were employed when carrying out in-depth investigations into the patterns of commuting activities generated by males and females for the whole period of study over nine years, followed by year on year analysis. The descriptive analysis shows that commuting times are becoming longer as time goes by. Year on year analysis reveals that commute trips by car made by males are more likely to prevail in the system compared to PT, especially towards the end of the study period in 2010–11. The opposite is true for female commuting trips. NMT was an attractive mode for both males and females in 2009–10 even for longer commute trip durations of over 50 min. As the complexity of the activity travel patterns of males and females has not been given adequate attention in previous research, this study made a step forward in investigating the gender aspects, with specific attention being given to the differences in commute times. Transport authorities' and policy makers' timely interventions, such as quality bus partnerships, cycle city guides, and cycle to work schemes, as well as Metro system reinvigorations, including smart ticketing, have been taken into account when rationalizing the results and the changes to commute times over the study period.

1. Introduction

The changing nature of commute behaviour has received considerable attention in recent years from researchers, planners and policy makers alike due to its potential association with social and environmental concerns. Lawton (1968), in one of the earliest investigations in this area, identified the growth in commute distances in Great Britain as being problematic. Since then, researchers have continued to investigate the changes in commuter travel. However, over the past several decades, increased attention has been paid to this subject due to increasing vehicle ownership rates and its adverse impacts on our society, economy and the environment, leading to problems such as urban

sprawl, traffic congestion, travel delays, traffic related emissions and health issues. Case studies conducted in France (Aguilera, 2005), Germany (Scheiner, 2010), Italy (Travisi et al., 2009), Netherlands (Susilo & Maat, 2007), Spain (Gracia-Palomares, 2010), Sweden (Sandow, 2008) and USA (Press, 2002; Shen, 2000) have explored the connection between urban structure and commuting patterns. Among recent studies in the UK, investigations into car ownership, commute travel mode, and time (Titheridge & Hall, 2006), the changing nature of commute patterns (Dainton, n.d.) and commuting trends (Dargay & Hanly, 2007) have contributed considerable knowledge to the subject of commuter travel.

The amount of time that commuters spend on their daily commute is

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vital to the evolution of urban systems in general, and to transport and land use patterns in particular. Easy access to the work place and the duration of the trip to work are fundamental to commuters in relation to decisions concerning where to live and where to work (*Commute Time Trends in the CMAP Region, 2015*). Long commute journeys, especially by car, have been found to generate an adverse influence on health and well-being (*Commute Time Trends in the CMAP Region, 2015; National Statistics, n.d.*). Longer commutes lead to lower levels of productivity at work, as well as financial burdens due to increased transportation costs (*Commute Time Trends in the CMAP Region, 2015*). In addition, negative utility generated by travel has been a major topic of discussion in transport research since the 1970s (*Yamada, 1972*). Therefore, travel patterns and their associated travel time warrant careful attention for comprehensive travel demand modelling and forecasting procedures to aid strategic decisions; for instance, value of travel time savings, transport system improvements, policy interventions, economic appraisal and transport investments. Commuting trips account for a greater proportion of the overall demand for travel in any country and therefore this study focuses on commute time to explore how it changes over an extended period of time.

According to the study by *Dainton, (n.d.)*, the percentage of commuter travel in the UK that takes less than 20 min has fallen since 2003. As reported by the UK Department for Transport (*DfT, 2007*), the average commute time was 27 min in 2006; that was an increase of 13% from the 1995/1997 figure of 24 min. It was reported that the number of workers who commute daily for 2 h or more in the UK increased by a third during 2011–16, with stagnant wages and soaring housing prices pushing people further away from their work places (*Trade Union Congress, 2016*). It is reasonable to assume that increased congestion on the network during peak periods may also be a possible reason for longer commute times. A study conducted in Minnesota (US) examined the reasons for large increases in commute times, with an 11% increase in the 1990s over the 1980s average figures. It ruled out land use factors and travel speeds from the set of factors influencing the change, but pointed to unemployment rates and gasoline prices in the 1990s as possible reasons for the changes in commute times (*Barns, 2007*). According to the *European Working Conditions Survey (2007)*, time spent on commuting journeys over complete home-work-home cycles in Europe has been in the range of 31.6–53.9 min. Within this range, the UK was ranked to be the 6th highest, with an average commute time of 45.4 min, out of 31 countries included in the survey.

The concept of “gendered mobility” has been popular in the context of transportation research in recent years. The differences between male and female commuters regarding their travel behaviour with respect to social interactions, work related commitments, household responsibilities and activity participation have been given attention in order to answer questions on how much, by what means and for what purposes they travel (*Polk, 1998; Uteng & Cresswell, 2008; Frandberg & Vilhelmson, 2011*). Early studies in the UK have identified that there are some similarities and differences between males and females with regard to their commute behaviour (*Dainton, n.d.; Pooley & Turnbull, 2000*). As reported recently, female commuters in the UK have shorter commute times than males (*Dainton, n.d.*). Past research confirms that males spend more time travelling than females (*Prendergast & Williams, 1981; Kitamura et al., 1992; Levinson & Kumar, 1995; Robinson, 1997*). There was a consistent trend observed for females in the UK until the mid-1990s regarding their tendency to opt for walking or using slower forms of public transport such as buses and trams (*Pooley & Turnbull, 2000*). Past research provides useful information about the differences between genders in commute behaviour. However, most of them investigate the issues in a broader sense rather than providing a comprehensive explanation of changes in commute behaviour of males and females over time.

Since there is currently a limited understanding of the changing nature of commute times over time, further research is required. This study therefore seeks to address the issue through analysis of household

travel data collected by UK National Travel Survey (NTS) coupled with a more detailed household travel survey in the Tyne and Wear Region in North East England during 2003–11. This will help to investigate how commute times have evolved over the years and how they can be linked into current and future policies to help promote a more sustainable urban environment. Hazard based duration technique is considered to be a suitable modelling tool in this analysis, given the nature of the analysis that is required. Previous research findings confirm that there is a substantial difference between males and females in how they organize their commuting journeys. Therefore the models were estimated separately to investigate gender differences in making commuting trips in general, and commute times in particular. The study uses the commute trips between home and work (and vice versa) without intermediate stops. The dataset does not include details of trip chaining behaviour and, due to the data limitations, the study focuses on direct home-work and work-home trips only.

This paper begins by presenting a critical review of previous research covering long-term changes in commuting time and modelling approaches for analysing commuting time data. The theory and suitability of Hazard based duration methods in transport research is also discussed. Attention is then directed towards a discussion of the study area and data description. This is followed by a presentation of the methodological approach and results of the analysis. The paper concludes with an explanation of potential reasons for changing commute times over time with attention to the case study area and directions for future research.

2. Analysing long-term changes in commuting time: a review of previous studies

The evolution of commuting time over a long-term period has been a point of discussion in previous research as a basis for policy making decisions. However, the definition of “long-term” has been rather ambiguous. Many studies making reference to “long-term analysis” only selected 2–3 discrete time points, typically at the beginning, middle and end of the overall study period (*Saad et al., 2016; Levinson & Wu, 2005; Levinson, 1998; Vandersmissen et al., 2003*). By doing so, they may have overlooked significant events in the interim periods due to environmental, political or economic changes. At least one study highlighted the benefits of performing analysis over a shorter time scale rather than the usual decennial census periods (*Saad et al., 2016*). Therefore analysis targeted at more frequent intervals, for example annually, is considered as having greater value.

In general, the changes in commute times have been characterized only by descriptive statistics, such as means and standard deviations, rather than considering more detailed analytical techniques, thereby taking advantage of the available datasets at disaggregate level (*Saad et al., 2016; Levinson & Wu, 2005*). This may be due to the fact that the objectives of those studies were somewhat diverse. For example, *Levinson and Wu (Levinson & Wu, 2005)* considered travel times for all trip purposes where a detailed analysis of commute times may not have been the main focus of their research. Similarly, the study by *Saad et al. (2016)* represented the changes to commute times by using spatio-temporal analysis with emphasis on data visualization. Therefore detailed analysis of changes to commute times was not presented in their research.

Analysis of commute durations using disaggregate data (e.g. individual level) is considered to be more useful as it has better predictive capabilities when compared to aggregate level analysis. However, only a few studies in the context of commute time have carried out disaggregate analysis (for example (*Press, 2002; Shen, 2000; Vandersmissen et al., 2003*)). Ordinary Least Square (OLS) regression (*Press, 2002; Shen, 2000; Levinson, 1998*) or logistic regression (*Vandersmissen et al., 2003*) were seen to be the most popular methods of analysis in previous research when exploring the changes in commute times in selected cross sections. However, researchers have

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