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Residential relocation as a key event in commuting mode shift

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ABSTRACT

Residential self-selection studies argue that pre-existing travel-related attitude overshadows the role of changes in residential built environment in (re)shaping travel behaviours. Our study contributes to this self-selection argument by including family- and job-related life events as another self-selection source, and accounting for the reverse causality from built environment to travel attitude as opposed to the attitude-induced self-selection. Using a two-wave sample of 1,038 Dutch residents before and after the relocation, we developed structural equation models to investigate longitudinal relationships between changes in residential built environment and job-housing distances, the occurrence of life events, and changes in commuting mode choices and preferences pre-post relocation. Results supported residential self-selection arising from pre-existing preferences for car and public transport commuting, while residents lowered the active commuting preference after moving to a more suburban neighbourhood. Life events concurrent with residential relocation, such as childbirth and job changes, also underlay greater demand for car use.

1. Introduction

Recognising the triggers of changes in population travel patterns is a prerequisite for managing travel demand and promoting sustainable ways of travelling (e.g., using public transport or active travel modes such as bicycle and walking). Travel behaviours, especially repetitive choices of commuting modes, are often the result of habitual routines in which people do not go through deliberate consideration every time they make travel-related decisions (Scheiner, 2007). According to the habit-discontinuity hypothesis, changes in the context will make behaviour-relevant information salient and stimulate people to reconsider their travel routines (Verplanken et al. 2008). Here the context includes the physical environment and infrastructure where behaviours take place, as well as relevant time and social cues such as the transition in social roles over the life course. Residential relocation represents such an abrupt change in spatial contexts, including changes in the residential built environment and job-housing relationships. For this reason, relocation and subsequent spatial changes may act as a trigger for the commuting mode shift.

The literature has been discussing whether the observed commuting mode shift following residential relocation is a result of changes in spatial contexts pre-post relocation, or just a manifestation of the pre-relocation travel attitude and socio-economic status of an individual. This widely-discussed debate is termed residential self-selection, or residential sorting phenomenon (Mokhtarian and Cao, 2008; Cao et al., 2009; Van Ham et al., 2012). For example, the coincidence between suburban living and car commuting may not be attributed to the suburban environment with poor access to the job centre and public transport systems, but rather results from

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residents' prior selection into the suburban neighbourhood depending on their high income or/and preferences for car use. From the perspective of residential self-selection, therefore, pre-existing travel attitude to a great extent drives the commuting mode shift, while the role of spatial contexts is to provide environmental opportunities to attract people with preferences for certain ways of commuting (e.g., developing transit-oriented suburban neighbourhoods to accommodate public transport enthusiasts; Næss, 2009; Ettema and Nieuwenhuis, 2017).

In this study, we argue that context changes along with residential relocation still play a structural role in influencing commuting mode choices over and above pre-existing travel attitude. First, residential relocation not only brings about a change in spatial contexts but also takes place because of the transition in personal and family life, which jointly lead to the commuting mode shift. According to the mobility biographies approach, the relocation event can be an adaptation to other life events embedded in people's immediate social contexts, especially those in the employment and household domains (Scheiner, 2014; Müggenburg et al., 2015). A case in point is that after a child is born, parents may simultaneously increase the demand for car use and a large living space in the car-dominant suburb (Oakil et al., 2016; Whittle et al., 2022). In this case, life events (e.g., childbirth), alike residents' travel attitude and socio-economic status, underlie a common reason for residential location choices and commuting mode choices (Zhang, 2014). Second, changes in socio-spatial contexts following residential relocation result in not only changes in commuting mode choices, but also changes in commuting mode preferences which script future mode use. This contradicts the assumption of residential self-selection studies; that is, travel-related attitude is stable over time (e.g., Handy et al., 2005). According to the learning process and the cognitive dissonance theory, however, people would adapt to the new place of residence not only by changing travel behaviours but also by adjusting travel attitude (Van Wee et al., 2019; Tao et al., 2022b). If so, travel attitude measured at post-relocation should not be regarded as a source of residential self-selection but rather a result of context changes pre-post relocation (Ewing et al., 2016).

As a contribution to the residential self-selection argument, our study takes a nuanced socio-spatial perspective to understand the condition under which residential relocation results in changes in commuting mode choices and mode-specific preferences. Using the Netherlands Mobility Panel, we developed a longitudinal research design pre-post the relocation event to answer the following two questions: (1) how do changes in spatial contexts (i.e., changes in residential built environment and job-housing distances) and the transition in personal and family life (i.e., the occurrence of family- and job-related life events) influence the commuting mode shift pre-post residential relocation, and (2) how do these context changes and resultant commuting mode shift further influence the commuting mode preference at post-relocation, after taking into account the effect of residential self-selection arising from residents' socio-economic status and commuting mode preference at pre-relocation.

The remainder of this paper is structured as follows. Section 2 presents an overview of the relocation research evidence on changes in commuting modes and travel attitude, followed by a conceptual framework in Section 3. Section 4 introduces the Netherlands Mobility Panel data and longitudinal structural equation modelling methods used in our study. Section 5 exhibits and explains the model results, and finally, Section 6 discusses the main research findings and provides some policy implications for travel demand management and sustainable transportation planning.

2. Literature review

2.1. Changes in commuting modes pre-post residential relocation

Urban and transport geographers have studied the relationship between the built environment and travel behaviours for decades (see the review articles by Ewing and Cervero, 2010, and Guan et al., 2020). A large body of cross-sectional evidence has documented that a compact and mixed-use neighbourhood with easy access to diverse transport facilities is correspondent with more trips by active mode and public transport there, while residents from a low-density neighbourhood with limited activity destinations and transportation infrastructure tend to own cars and use them for daily long-distance trips (e.g., Handy et al., 2005; Schwanen and Mokhtarian 2005; Van Acker and Witlox, 2010; Tao et al., 2022a). To further identify the environment-travel causality, recent studies focus on the event of residential relocation to compare within-individual changes in travel behaviours pre-post relocation (e.g., Cervero and Day, 2008; Scheiner and Holz-Rau, 2013; Zhao and Zhang, 2018; De Vos et al., 2021a, b). Their rationale for better causal inference is that changes in environmental exposures precede changes in behavioural responses in time, and any between-individual idiosyncratic confounders (e.g., travel-related attitude) are controlled for by the within-individual analysis.

However, evidence from relocation-based commuting behaviour research is mixed in concluding the impact of changes in built environment characteristics on changes in commuting mode choices. Results from the regional-scale built environment shows that relocating to the suburb induces a switch to the car for commuting, while moving closer to the city centre leads to more frequent use of public transport and active modes (Scheiner and Holz-Rau, 2013; Beige and Axhausen, 2017). In contrast, some other studies claim that the impact of general relocation direction is negligible (Oakil et al., 2016), or depends on the urban structure under study (e.g., the distance to the main city centre or the second-order centre; Næss, 2015; Engebretsen et al., 2018). Compared with the effect of regional built environment, commuting mode shift is more directly linked to changes in job-housing distances and local built environment at residence. There is consistent evidence that the longer the commuting distance is following the relocation, the higher the probability that people acquire additional cars and switch to the car for commuting (Clark et al. 2016; Yang et al., 2017; Zhao and Zhang, 2018; Whittle et al, 2022). In addition, moving to a neighbourhood accessible to frequently-running and high-quality transit lines makes public transport a competitive alternative to the car for long-distance commuting trips (Cervero and Day, 2008; Cao et al. 2019; Ibraeva et al., 2022).

The mixed findings for the causal relationship between built environment and commuting modes may lie in the residential self-selection (or residential sorting phenomenon). Its basic idea is that people select the place of residence to match their travel

demand, abilities and preferences (see Mokhtarian and Cao, 2008 for a review of research methodologies, and Cao et al., 2009; Guan et al., 2020 for a review of empirical findings). Simply put, people may decide on the residential location in advance of the actual move based on their socio-economic status (e.g., income and ethnicity) and travel attitude. Regarding the self-selection from the mode-specific preference, a mismatch between the commuting mode choice and preference may constitute a reason for moving home. In this regard, previous self-selection studies often follow a retrospective survey design to collect attitudinal information after residents have changed their houses. This *post-hoc* measure of travel attitude is then used to infer the self-selection process that occurred at an earlier time (e.g., Handy et al., 2005; Cao et al., 2007; De Vos et al. 2018; Zhao and Zhang, 2018; Guan and Wang, 2020). Their study results have come to a general consensus that travel-related self-selection is at play because most residents move to a neighbourhood that allows the use of their preferred means of transport; However, residential built environment and job-housing distances still exert an independent effect on commuting mode choices besides the self-selection effect resulting from residents' travel preferences.

Notably, residential self-selection studies have argued much on the role of changes in spatial contexts (i.e., residential built environment and job-housing distances) for commuting mode shift, but overlook the fact that daily commuting behaviours are subject to habitual routines and embedded in people's social life. In this respect, life-oriented travel behaviour studies and the mobility biographies approach have provided solid theoretical justification for the stability and changes in travel behaviours over the life course. Life-oriented travel behaviour studies propose that people's past experiences gradually accumulate to shape current travel demand and preferences. However, a sequence of events in life evoke the transition in social roles and statuses, which has the potential to reshape travel behaviours (Beige and Axhausen, 2017; Zhang, 2014; Zhang and van Acker, 2017). Echoing this, the mobility biographies approach specifies the reasons for daily mobility changes, including changes in travel behaviours and mobility tool availability such as car ownership, by the events in three life domains: changes in household composition in the household domain (e.g., childbirth, moving out of or into the household), job-related events in the employment domain (e.g., job changes and retirement), residential relocation and corresponding changes in accessibility and the built environment in the residential domain (Lanzendorf, 2003; Scheiner, 2007). It has to be emphasised that these events are not isolated but interrelated with each other in life, which jointly influence people's daily mobility (Müggenburg et al., 2015; Tao et al., 2022b).

Based on the mobility biographies, residential relocation can be conceptualised as an adaptation to events in the household and employment domains because the relocation event is often coincided, or even induced, by other family- and job-related life events (Müggenburg et al., 2015). In the household domain, relocation is likely to take place when people give birth to a child, start and stop cohabitating with the partner, or undergo other changes in household composition (Scheiner and Holz-Rau, 2013; Clark et al., 2016; Guan and Wang, 2020). Each of these family-related life events conveys a specific form and meaning of residential relocation, and thus, evokes the reconsideration of former travel habits. Likewise, in the employment domain, the co-location hypothesis claims that individuals adjust their housing locations closer to job locations or vice versa as a way to temper commuting changes (Cervero and Day, 2008; Van Ham et al., 2012), even though existing longitudinal evidence is inconsistent to substantiate the job-housing co-location (Prillwitz et al., 2007; Beige and Axhausen, 2017; Guan and Wang, 2020).

2.2. *Changes in travel attitude pre-post residential relocation*

Attitude is broadly defined as a favourable or unfavourable inclination toward the evaluated object (e.g., travel) based on people's needs, values and tastes (Ajzen and Fishbein, 1977). In residential self-selection studies, travel-related attitude, or more specifically the preference for certain travel modes, is regarded as an antecedent to the choice of residential locations and travel behaviours. This claim on the exogenous nature of attitude in relocation decision-making originates from socio-psychological theories. In the well-known theory of planned behaviour, for example, the intention and occurrence of behaviours are incurred by the time-invariant attitude, along with subjective norms and perceived behaviour control (Ajzen, 1991). This makes explicit the causal direction running from attitude to behaviour and lends support to the retrospectively residential self-selection studies. If travel attitude does not vary over time, these self-selection studies should not be criticised for using travel attitude measured at post-relocation to infer the preceding housing selection process.

However, travel attitude is not a stable construct but subject to change under certain circumstances, suggesting the endogeneity of travel attitude in the environment-travel causality. Recent critical reviews by Van Wee et al. (2019), Guan et al. (2020) and Tao et al. (2022b) have argued that travel attitude can be reshaped by changes in travel demand (e.g., car dependence after childbirth), environmental opportunities (e.g., limited public transport services at residence), and mobility cultures (e.g., programs of cycling to work in the company). Following this train of thought, the reverse effect of built environment on travel attitude makes more sense in the retrospective self-selection studies, because residents may have adjusted their travel attitude after living a while in the new place of residence (Ewing et al., 2016).

While theoretically established, there is little empirical evidence on attitudinal changes (except Kroesen et al., 2017, Olde Kalter et al., 2020; McCarthy et al., 2023) due to limited longitudinal data that prospectively investigate the same respondents over time. Especially after residential relocation, changes in travel attitude are more likely to be the case given the unstable socio-spatial contexts. In this case, there are two possible pathways underlying changes in travel attitude. The first pathway, the adjustment to cognitive dissonance, takes effect when people face constraints to move into the neighbourhood in line with their desired way of travelling. The inconsistency (or dissonance) between travel behaviours and attitude would arouse a feeling of discomfort, which motivates people to adjust travel attitude to better match their behaviours (Festinger, 1957; De Vos and Singleton, 2020). The second pathway, the learning process, occurs when people do not take travel-related factors into serious consideration for relocation decision-making. After the relocation, they will immerse in a different spatial setting, consciously search for travel-related information, and alter their stance toward available travel choices (Bohte et al., 2009). In addition, direct travel experiences are a more active form of learning. After

using the alternative travel mode stimulated by the new place of residence, people may correct and adapt their pre-existing preference for that mode (Næss, 2009; Van Wee et al., 2019).

The impact of built environment or travel behaviours on travel attitude is termed the reverse causality, as opposed to the residential self-selection where travel attitude predisposes the choice of residential locations and travel behaviours (Van de Coevering et al., 2018; Van Wee et al., 2019). While increasing studies have examined the bi-directional relationships between built environment and travel attitude (e.g., Ewing et al., 2016; Lin et al., 2017; Van de Coevering et al., 2016, 2018; Kroesen, 2019), there is limited evidence drawing upon the real panel data pre-post the event of residential relocation. Following a quasi-longitudinal research design, De Vos et al. (2021a, b) ask relocated residents in the city of Ghent, Belgium to retrospect their changes in residential locations (measured by self-reported changes in the urbanised levels of the neighbourhood), travel mode use and mode-specific attitude pre-post relocation. The results show that residents develop more positive attitude toward public transport and active modes after moving to a more urbanised neighbourhood. However, these quasi-longitudinal studies fail to take into account the baseline status at pre-relocation, especially the residential self-selection from pre-existing travel attitude, given only the information on *changes* investigated. To our best knowledge, Wang and Lin (2019) provide the only longitudinal evidence that simultaneously tests the residential self-selection and reverse causality hypotheses. Their research draws upon a two-wave panel survey on 229 residents before and after their relocation in Beijing, China. Results from the structural equation models suggest little evidence of residential self-selection on the one hand, because travel mode preferences at pre-relocation do not predict the choices of residential built environment and the commuting

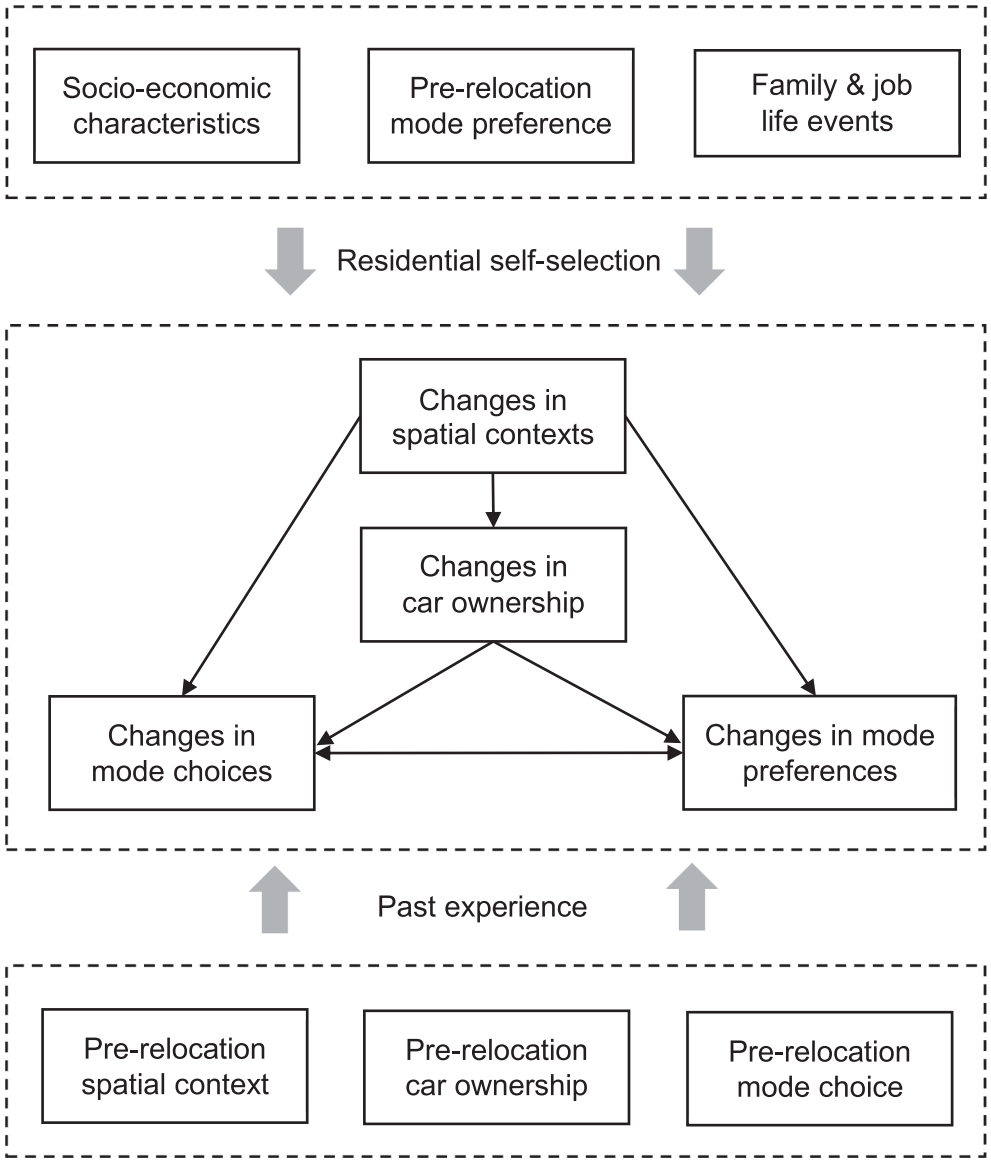

Fig. 1. Conceptual model.

distance at post-relocation. On the other hand, the reverse causality is established because residents state a preference for active travel modes after moving to a densely populated and easily accessible neighbourhood.

Moreover, life events occurring at the time of residential relocation may also engender a transition in travel attitude. This attitudinal transition involves several causal mechanisms, including spurring a deliberation process, changing travel demand, and altering social roles and norms (Clark et al., 2016; Janke and Handy, 2019). Longitudinal studies of this kind have examined the independent effects of different life events on attitudinal changes. For example, young parents tend to appreciate car use after giving birth to a child because of more tight time schedules and constraints of coordination (Kroesen, 2019; Whittle et al., 2022). However, less studied is how travel attitude varies as a result of interrelated life choices, especially the residential relocation that often corresponds with job changes and changes in household composition. To this end, a socio-spatially contextual perspective that links the relocation event with other family- or job-related events is warranted to account for not only changes in travel behaviours but also changes in travel attitude.

3. Conceptual model

According to the literature review, residential self-selection is still an area of debate concerning the reverse causality issue and the self-selection resulting from family- or job-related life events. These debates reflect three different but interrelated perspectives on how residential relocation and associated context changes influence, or are influenced by, people's travel behaviours and attitude: First, relocation may be induced by travel-related self-selection where prepositioned travel attitude drives the choice of residential locations and travel behaviours. Second, relocation may be an adaptation to other life events, such as childbirth and job changes, along with varying travel demands and preferences. Third, relocation itself may be a key event in changing travel behaviours and attitude through the exposure to new spatial contexts and the intention to break travel habits.

Based on these considerations, our study constructed the conceptual model in Fig. 1 to jointly analyse the relationships between changes in residential built environment and job-housing distances (i.e., spatial contexts), the occurrence of life events, and changes in commuting mode choices and preferences before and after residential relocation. This pre-post analysis is recommended as an appropriate way to examine the causal relationship between the built environment and travel behaviours, and to identify the transition in travel attitude after major changes in life (Mokhtarian and Cao, 2008; Næss, 2009; Guan et al., 2020; De Vos, 2022; Tao et al., 2022b). As shown in Fig. 1, changes in spatial contexts pre-post relocation are likely to result in not only changes in commuting mode choices but also changes in commuting mode preferences, while changes in commuting mode choices and preferences were interrelated with each other. Given the mobility tools, especially the car, required for commuting mode shift (Van Acker and Witlox, 2010; Scheiner, 2014; Wang and Lin, 2019), we additionally introduced changes in household car ownership as a mediator to account for the indirect effect of changes in spatial contexts on changes in commuting mode choices and preferences. Moreover, three possible sources of residential self-selection were taken into account, i.e., individual and household socio-economic characteristics, pre-relocation commuting mode preferences, and family- and job-related life events concurrent with the relocation event. Besides, we also included the spatial contexts, household car ownership and commuting mode choices at pre-location to control for the influence of preceding living experiences and travel habits.

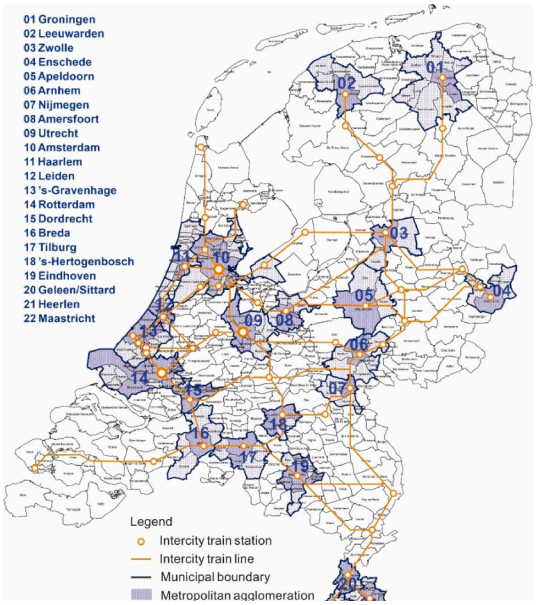

Fig. 2. Urban regions and intercity train networks in the Netherlands.

4. Data and methods

4.1. Data

Our study drew upon the Netherlands Mobility Panel (*Mobiliteitspanel Nederland* in Dutch, MPN) data. MPN is a nationwide longitudinal survey in which over 7,000 respondents aged 12 and above have been asked to complete an online questionnaire every year since 2013. Compared with traditional survey methods (e.g., mail surveys), the web-based longitudinal data collection has the special advantage of following respondents who have changed their registered residential addresses between survey waves. To ensure the representativeness of the online sample for the Dutch population, the MPN respondents were drawn from an existing access panel that is well-balanced in respondents' socio-economic characteristics. For detailed sample recruitment and possible selection bias, see Hoogendoorn-Lanser et al. (2015). In each wave of the surveys, respondents reported their daily travel modes and current mode-specific preferences for different purposes (e.g., commuting). They also recorded major changes in life between survey waves, including changes in household composition, residential locations, car ownership and work conditions. This unique combination of longitudinal information on travel behaviours, travel attitude and life events enables the analysis of changes in commuting mode choices and preferences over time.

We chose the Netherlands as the case area because of more opportunities for travel-related residential self-selection compared with the US and some Asian countries such as China. The Netherlands is characterised by compact urban forms with mixed land uses and accessible job (sub)centres. Fig. 2 shows that in the Netherlands, there are 22 functional urban regions where most of the populations from surrounding areas commute to work and conduct routine activities. These polycentric urban regions provide the commuting population with diverse options to choose job-housing relationships and great chances to meet travel preferences. Moreover, there are competitive alternatives to cars given the good quality of public transport networks and cycling infrastructure in the Netherlands. Even so, there is still room for expanding bicycle use, especially for the commuting purpose, given that over half of the car commuting trips are currently within the cycling distance (<7.5 km; Rijksoverheid, 2018).

Source: modified by the Statistics Netherlands (2015) and the NS rail map 2020.

Our study selected the respondents who regularly commuted to work and relocated their home locations between the survey waves of 2013 and 2019. Each studied respondent had completed continuous two-wave surveys, the wave before and the other wave after the relocation. Table 1 shows baseline socio-economic characteristics and residential areas of the commuting respondents who had relocated their houses, with those of all commuting respondents as a comparison. As expected, relocated commuting respondents were younger, better educated, and more likely to be singles from low-income carless households and highly urbanised areas compared with

Table 1
Baseline socio-economic and residential characteristics of the relocated commuting respondents and all commuting respondents in the MPN dataset.

		Relocated respondents[a] (N = 1,038)	MPN respondents[a] (N = 7,113)
Gender	Men	49.9	49.6
	Women	50.1	50.4
Age	18–29	16.8	16.8
	30–39	27.4	22.1
	40–49	30.4	27.0
	50–69	20.3	34.1
Education	Elementary or secondary education	12.4	22.5
	Vocational education	34.3	42.1
	University or higher education	53.3	35.4
Household type	Singles, no children	37.2	18.6
	Single parents	5.9	6.2
	Couples, no children	22.7	24.1
	Couples with children	32.6	48.9
	Others	1.6	2.2
Household income levels	Low income (<26,200 euros/year)	27.0	17.5
	Middle-low income (26,200–38,800 euros/year)	24.5	22.1
	Middle-high income (38,800–65,000 euros/year)	27.3	37.1
	High income (>65,000 euros/year)	21.2	23.3
Household car ownership levels	No car	19.7	10.2
	1 car	52.1	48.7
	2 or more cars	29.2	41.1
Residential location	High-urbanised areas (>1,500 inhabitants/km^2)	62.8	49.4
	Moderate-urbanised areas (1,000–1500 inhabitants/km^2)	15.0	20.8
	Low- or non-urbanised (<1,000 inhabitants/km$^{2)}$	22.2	29.8

a. Results are show in %.

the general commuting population. Non-movers were excluded from the analysis because they had little variation in residential built environment over the survey waves. More importantly, residential self-selection only applied to people who had actually exercised the act of relocation.

4.2. Variables

There are five subsets of the variables, including travel behaviours and attitude, residential built environment and job-housing relationships, life events, household car ownership, and socio-economic characteristics. Notably, all variables, except life events and time-invariant socio-demographics (i.e., gender, age and educational attainment), were included in the modelling analysis by the baseline value before the relocation and the difference in value (i.e., *changes*) pre-post relocation. These variables of interest are introduced in Table 2 and explained in detail below.

Travel behaviours and attitude were respectively operationalised as the travel mode choice and the mode-specific preference for commuting trips pre-post residential relocation. To accurately estimate the behaviour-attitude interrelations, these two measures were uniformly specific to the dimension of travel modes and the purpose of commuting to work (Bohte et al., 2009; Kroesen et al., 2017). Here, the commuting mode preference represents the general disposition towards certain travel mode that is used for commuting trips, underlying multiple dimensions of travel-related attitude (e.g., the ability, attractiveness, and environmental and safety concerns of car use; Næss, 2009; Scheiner, 2014). In the MPN survey, respondents were required to name the means of transport that they used most frequently and preferred to use to commute. Their answers were coded as car, public transport (PT), walking and bicycle (use or preferences). Considering the small number of walking as the most frequently used and the preferred commuting mode, we combined walking and bicycle into the active mode (AM) for the modelling analysis.

Job-housing distances and residential built environment attributes relevant to the commuting trips defined the spatial contexts before and after the relocation. These environmental attributes were measured at different scales, ranging from the regional scale to the neighbourhood scale. Specifically, the distance (from the residence measured at the 6-digit postal code) to the nearest urban region centre described the residential location at the regional scale, while its changes pre-post relocation outlined the general relocation direction, i.e., moving closer to or away from the urban region. Besides, the distance to the workplace and its changes measured the job-housing relationships over space, while the distance to the nearest intercity train station and its changes evaluated how easy commuters could access high-quality public transport infrastructure at residence.

Life events in the household and employment domains were included to identify the transition in personal and family life in the same year of residential relocation. In the household domain, we chose childbirth, cohabitation and separation to describe major changes in family life. In the employment domain, we used changes in the workplace to examine the co-location pattern of job and housing locations. Changes in household income were also included to adjust for the income effects along with job changes. Besides, household car ownership was measured by the number of cars in the household before and after the relocation, while socio-economic characteristics were composed of gender, age, educational attainment and annual household income at pre-relocation.

4.3. Methods

Our study used longitudinal structural equation models (SEMs) to empirically examine the conceptual framework in Fig. 1. Unlike the multivariate regression that estimates a single outcome by a series of indicators, SMEs allow the analysis of multi-stage interdependencies between endogenous variables (i.e., variables are simultaneously treated as the outcome in a set of relationships and as the indicator of the outcome in other relationships), after taking into account the influence of exogenous indicators on endogenous outcomes. Therefore, it is suitable for our study to employ longitudinal SEMs to investigate the endogenous relationships between changes in spatial contexts, car ownership, commuting mode choices and mode-specific preferences pre-post residential relocation, as well as to account for the exogenous impacts, especially, of family- and job-related life events.

SEMs were specifically constructed as follows. We firstly divided the respondents based on their baseline commuting modes at pre-relocation (i.e., non-car users, non-PT users and non-AM users), and then, fitted three SEMs to explain the process of switching to each

Table 2
Variable settings.

Category	Description	Measures	Type
Commuting mode choice	Main means of transport used for commuting trips	Switching to commuting by car (or not), public transport, and active mode (i.e., bicycle and walking)	Binary
Commuting mode preference	Preferred means of transport for commuting trips	Preferring commuting by car (or not), public transport and active mode at pre-relocation and at post-relocation	Binary
Spatial contexts	Residential built environment and job-housing relationships	Baseline distances to the urban region centre, the job location and the intercity train station at pre-relocation, and changes in values pre-post relocation	Continuous
Life events	Family- and job-related life events	The occurrence of childbirth, cohabitation, separation, job changes and income changes in the same year of relocation	Binary
Household car ownership	The number of cars in the household	Baseline household car numbers at pre-relocation and changes in car numbers pre-post relocation	Continuous
Socio-economic characteristics	Individual socio-demographics and household income	Gender, educational attainment, age in category, and baseline household income at pre-relocation	Categorical & continuous

commuting mode of interest (i.e., switching to car, switching to PT and switching to AM) with the reference of maintaining the commuting mode pre-post relocation. Dividing the respondents into these mode-specific commuting groups contributes to identifying the causal effect of commuting mode choices on commuting mode preferences. The reason is that the mode switch behaviour occurred at an earlier time than the stated mode preference at post-relocation, and this causal inference is established after controlling for the mode preference at pre-relocation. The reverse effect of changes in commuting mode preferences on changes in commuting mode choices pre-post relocation was not investigated in our SEM analysis.

We used the weighted least square mean and variance adjusted (WLSMV) estimators to fit the SEMs. Compared with the maximum likelihood (ML) estimator, WLSMV estimators perform better in reducing the possibility of type I errors and estimating the endogenous variables that are not normally distributed (Kline, 2016). This is particularly the case for our binary outcomes of commuting mode shift and post-relocation mode preferences. The SEM analysis was undertaken using the program *Mplus*.

5. Results

5.1. Descriptive results for changes in commuting mode choices and preferences

Table 3 describes changes in commuting mode choices and preferences based on the relocation direction (i.e., relocating away from or closer to the urban region centre). Notably, not only commuting mode choices but also mode-specific preferences varied pre-post relocation. Regarding changes in commuting mode choices, car use was more stable than public transport (PT) and active mode (AM) use. Nearly 80% of the pre-relocation car commuters maintained their car use at post-relocation, while around half of previous PT and AM users switched to other commuting modes. Especially for pre-relocation active commuters, more than one-third of them switched to car use after moving to a place farther away from the urban region. By contrast, around 30% of pre-relocation PT users turned to AM use after relocating closer to the urban region. Regarding changes in commuting mode preferences, only 40.8% of the respondents who preferred PT commuting at pre-relocation maintained this preference afterwards. When previous PT enthusiasts moved closer to the urban region, however, they were more likely to prefer AM rather than car commuting (41.0% versus 14.7%). Besides, >60% of the respondents repeatedly stated car or AM as the preferred commuting mode pre-post relocation. Taken together with the results for the active mode shift, it is possible that some former active commuters had to give up AM use after the relocation even though they still desired to use that mode.

5.2. The goodness-of-fit of the SEM models

Three SEMs were fitted to understand the mechanism underlying each mode switch behaviour (i.e., switching to car, PT and AM) and the impact on post-relocation mode preference. In the raw SEMs that linked all the paths between variables, the goodness-of-fit indices of the models just met the recommended values. This is not surprising because raw SEMs were saturated with limited degrees of freedom (d.f.). Besides, most of the baseline socio-demographic characteristics at pre-relocation did not show significant impacts on endogenous variables that were measured by *changes* in value. To improve the mode fit, we removed those insignificant paths (at $p < 0.10$) between socio-demographics and endogenous variables, following Wang and Lin (2019) and De Vos et al. (2021a, b). After the path removal, results for other variables hardly changed, and the adjusted SEMs fitted the data well as indicated by the commonly-used goodness-of-fit indices (Chi-square/d.f. = 0.57–0.92, CFI = 1.00–1.00, TLI = 1.01–1.04, RMSEA = 0.00–0.01, SRMR = 0.02–0.03; Table 4).

5.3. SEM results for endogenous variables

Results from the adjusted SEMs are shown in Fig. 3 and Tables 5-7. Fig. 3 illustrates the relationships between endogenous variables

Table 3
Changes in commuting mode choices and preferences before and after residential relocation[a].

			The post-relocation wave								
			All relocated respondents			Relocation away from the urban region centre			Relocation closer to the urban region centre		
			Mode choice			Mode choice			Mode choice		
			Car	PT	AM	Car	PT	AM	Car	PT	AM
The pre-relocation wave	Mode choice	Car	79.8	6.9	13.3	81.1	5.0	13.9	78.0	7.4	13.6
		PT	24.8	51.0	24.2	26.5	54.4	19.1	19.6	49.0	31.4
		AM	32.9	16.3	50.8	37.0	18.8	44.2	28.7	9.6	61.7
			Mode preference			Mode preference			Mode preference		
			Car	PT	AM	Car	PT	AM	Car	PT	AM
	Mode preference	Car	68.2	7.0	24.8	68.8	6.7	24.5	67.2	6.4	26.4
		PT	22.4	40.8	36.8	26.9	39.0	34.1	14.7	44.3	41.0
		AM	26.1	13.8	60.1	26.8	14.1	59.1	25.6	10.7	62.7

a. Results are show in %.

Table 4
Goodness-of-fit indices for three SEM models.

	Recommended values	Switching to car model (N = 484)	Switching to PT model (N = 885)	Switching to AM model (N = 707)
Chi-square/degrees of freedom, d.f.	<5	0.73	0.92	0.57
CFI: Comparative fit index	>0.95	1.00	1.00	1.00
TLI: Tucker-Lewis index	>0.95	1.03	1.01	1.04
RMSEA: Root mean square error of approximation	<0.05	0.01	0.00	0.00
SRMR: Standardized root mean square residual	<0.05	0.02	0.03	0.02

for respondents who respectively switched to car, PT and AM for commuting after the relocation. A notable finding is that in all three models, switching to a commuting mode pre-post relocation had a strong and significant impact on the preference for that mode at post-relocation. This impact was established after adjusting for the pre-relocation mode preference. That is to say, a fresh experience of commuting by car, PT or AM after the relocation helped to develop a positive stance toward the chosen mode.

Regarding the role of spatial contexts, regional built environment did not directly influence commuting mode shift, but it did exert indirect effects through changes in job-housing distances and public transport accessibility at residence. Given the polycentric urban regions in the Netherlands, relocation with an increased distance to the centre of an urban region was associated with corresponding

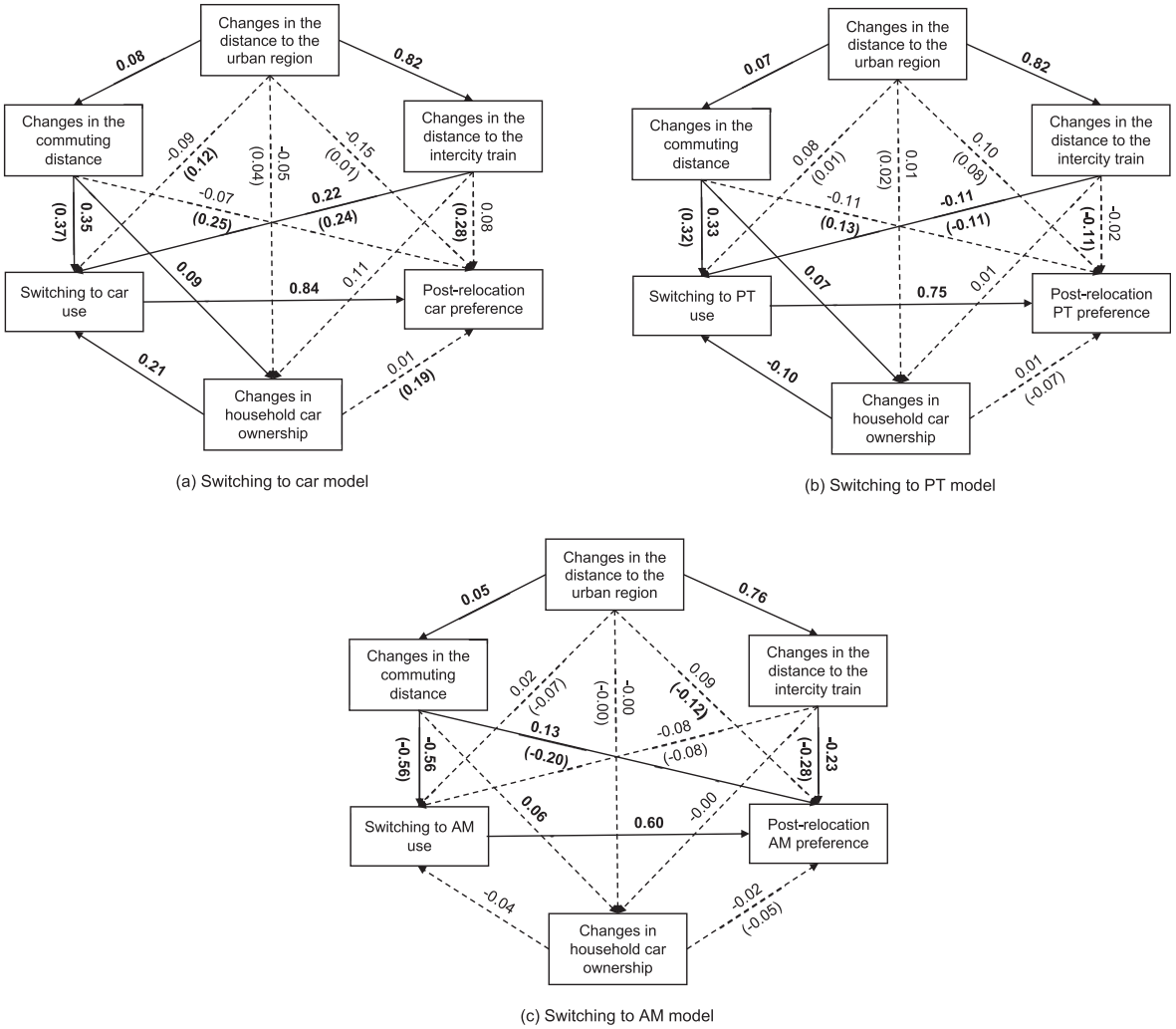

Fig. 3. SEM results for the standardised direct effects and total effects (in parentheses) between endogenous variables. Note. Numbers in bold refer to significant direct effects and indirect effects (in parentheses) at $p < 0.05$. Solid lines represent significant direct effects while dashed lines represent insignificant direct effects.

Table 5
Standardised direct effects between exogenous and endogenous variables in the SEM model for switching to car use.

	Post-relocation car preference	Switching to car use	Changes in household car ownership	Changes in the distance to the urban region centre	Changes in the commuting distance	Changes in the distance to the intercity train station
Car preference at pre-relocation	0.31**	0.60**	0.25*	0.26*	0.26**	−0.03
Childbirth	−0.13	−0.13	0.52**	0.21	−0.02	−0.21
Cohabitation	−0.02	0.12	0.02	0.24	0.21*	0.06
Separation	0.27*	0.23	−0.35*	0.04	−0.16	0.04
Job changes	0.01	0.20*	0.28**	0.03	0.09	−0.05
Income changes	0.07	−0.04	0.14**	−0.06	0.00	−0.01
Household car ownership at pre-relocation	−0.10	0.86**	−0.69**	0.17	0.06	0.16*
Distance to the urban region centre at pre-relocation	0.05	−0.16	−0.01	−0.32**	−0.04	0.29**
Commuting distance at pre-relocation	0.09	0.09	0.06	0.05	−0.56**	−0.06
Distance to the intercity train station at pre-relocation	−0.06	0.26*	0.05	−0.10*	0.09	−0.32**
Household income at pre-relocation	0.07	−0.03	0.11*	−0.06	0.04	−0.04
Men (ref. women)	–	–	–	–	0.10	–
Age: 30–39 (ref. < 30)	–	–	0.13	–	–	–
Age: 40–49	–	–	–	–	–	0.40
Age: 50–69	−0.33*	–	0.41**	–	–	–
Education: Vocational (ref. elementary or secondary)	–	–	–	–	–	–
Education: University or higher	–	–	–	–	–	–

Note. Significance: * $p < 0.05$, ** $p < 0.01$. – represents the insignificant paths ($p > 0.10$) excluded from the SEM.

Table 6
Standardised direct effects between exogenous and endogenous variables in the SEM model for switching to PT use.

	Post-relocation PT preference	Switching to PT use	Changes in household car ownership	Changes in the distance to the urban region centre	Changes in the commuting distance	Changes in the distance to the intercity train station
PT preference at pre-relocation	0.48**	0.86**	−0.00	−0.12	0.14	−0.18*
Childbirth	−0.06	−0.41*	0.02	0.07	−0.03	0.05
Cohabitation	0.09	0.08	0.14	0.04	0.16*	−0.01
Separation	0.32	−0.40	−0.25*	0.07	−0.08	−0.10
Job changes	−0.12	0.11	0.13*	−0.01	0.03	0.01
Income changes	−0.05	−0.01	0.14**	0.00	−0.02	−0.07
Household car ownership at pre-relocation	0.09	−0.63**	−0.53**	0.19	−0.00	0.12
Distance to the urban region centre at pre-relocation	0.04	−0.10	0.12	−0.41*	0.04	0.37**
Commuting distance at pre-relocation	0.01	0.13*	0.05	0.04	−0.55*	−0.02
Distance to the intercity train station at pre-relocation	0.00	−0.05	−0.09	0.06	0.03	−0.42**
Household income at pre-relocation	−0.06	0.08	0.05	−0.07*	−0.03	−0.04
Men (ref. women)	–	–	–	–	0.14*	–
Age: 30–39 (ref. < 30)	−0.32*	–	0.26**	–	–	–
Age: 40–49	–	−0.42*	–	–	–	–
Age: 50–69	–	−0.30	–	0.19*	–	–
Education: Vocational (ref. elementary or secondary)	–	–	0.19	–	–	–
Education: University or higher	–	–	0.18	–	–	0.18

Note. Significance: * $p < 0.05$, ** $p < 0.01$. – represents the insignificant paths ($p > 0.10$) excluded from the SEM.

Table 7
Standardised direct effects between exogenous and endogenous variables in the SEM model for switching to AM use.

	Post-relocation AM preference	Switching to AM use	Changes in household car ownership	Changes in the distance to the urban region centre	Changes in the commuting distance	Changes in the distance to the intercity train station
AM preference at pre-relocation	0.52**	0.64**	−0.01	−0.06	−0.07	−0.01
Childbirth	−0.18	−0.13	0.02	0.15	−0.09	−0.08
Cohabitation	−0.08	0.06	0.27*	0.07	0.08	−0.02
Separation	0.15	0.20	−0.29**	0.16	0.07	0.02
Job changes	−0.01	0.23*	0.14	0.02	0.01	−0.02
Income changes	0.00	0.06	−0.13	0.00	−0.09	−0.03
Household car ownership at pre-relocation	−0.13	−0.12	−0.68**	0.26*	0.13	0.10
Distance to the urban region centre at pre-relocation	0.08	0.12	0.08	−0.38**	−0.05	0.33**
Commuting distance at pre-relocation	0.10	−0.35**	0.06	0.01	−0.48**	−0.02
Distance to the intercity train station at pre-relocation	−0.17*	−0.26**	0.04-	0.05	0.08	−0.40**
Household income at pre-relocation	−0.02	−0.09	0.14	0.04	0.06	0.01
Men (ref. women)	–	–	–	–	0.29**	–
Age: 30–39 (ref. < 30)	–	−0.09	0.18*	–	0.15*	–
Age: 40–49	–	–	–	–	–	–
Age: 50–69	–	–	–	0.20*	–	0.11
Education: Vocational (ref. elementary or secondary)	–	−0.15	0.22*	–	–	–
Education: University or higher	0.21	–	0.25*	–	–	–

Note. Significance: * $p < 0.05$, ** $p < 0.01$. – represents the insignificant paths ($p > 0.10$) excluded from the SEM.

increases in the commuting distance and the distance to an intercity train station. As a result, respondents who commuted longer distances were more likely to start using cars or PT for commuting and less likely to switch to AM use. Also, worse accessibility to intercity trains was related to a lower likelihood of switching to PT use and a greater likelihood of switching to car use.

Besides the effects on commuting mode shift, spatial contexts also mattered for commuting mode preferences. This is especially the case for the active commuting preference given the significant direct effects of changes in residential built environment and job-housing distances on the preference for active commuting at post-relocation. As respondents relocated farther away from the intercity train station, they were less likely to prefer walking or cycling for (part of the) commuting trips. On the contrary, respondents would miss the benefit of short-distance active commuting and exhibit a greater preference for AM use with the increase of commuting distances. Even so, the total effect of increased commuting distances on the post-relocation AM preference was negative because the indirect effect through discouraging a switch to AM was much larger in magnitude. Taken together, a suburban relocation away from the urban region negatively predicted the active commuting preference in the total effect. Regarding the results for car and PT commuting preferences, there were insignificant direct effects of changes in residential built environment and job-housing distances on post-relocation mode preferences, while the total effects, especially the indirect effects through commuting mode shift, were significant in expected directions.

In line with previous research evidence (e.g., Van Acker and Witlox, 2010; Wang and Lin, 2019; Whittle et al., 2022), changes in household car ownership acted as a mediator between changes in commuting distances and switching to car or PT use. When respondents moved away from their job locations, they would acquire more cars and start using them for commuting trips. Instead, longer commuting distances marginally impeded the mode switch to PT if respondents increased household car numbers following the relocation.

5.4. SEM results for exogenous variables

Results for the pre-relocation mode preference indicated residential self-selection arising from the pre-existing preferences for car and PT commuting. Specifically, a predilection for car commuting at pre-relocation stimulated a move to the place away from the urban region and the job location, which further increased the number of family cars and their use for commuting. By contrast, respondents who had regarded PT as the preferred commuting mode chose to relocate closer to the intercity train station. However, commuting-related self-selection did not apply to respondents who preferred active commuting before the relocation. This means that walking and cycling enthusiasts might not find a suitable house close to the workplace, or they did not even consider satisfying their commuting preference through residential relocation. Even so, the commuting mode preference at pre-relocation is a strong indicator of the commuting mode choice and preference at post-relocation, for the three studied means of transport alike. This result aligns with

other studies indicating that prepositioned travel attitude has an autonomous impact on subsequent travel behaviours, but does not always translate into the long-term decision on residential locations (Ettema and Nieuwenhuis, 2017; Wang and Lin, 2019).

Life events concurrent with residential relocation also predicted the commuting mode choice and preference at post-relocation, especially through changes in household car ownership. In the household domain, specifically, respondents would acquire additional cars when relocation and childbirth events happened in the same year. Afterwards, they tended to start car commuting and not to switch to PT. Besides, the cohabitation event was related to increased commuting distances, because respondents were required to negotiate a common housing location with their partners at the cost of the proximity to their own workplaces (Wang et al., 2020; Tao et al., 2023). In contrast, the separation event decreased household car numbers, possibly as a result of the financial loss and the moving out from the former car-owning households (Scheiner, 2007). Despite this, the decrease in car numbers might not lead to a decline in car use in the long term, considering that respondents showed a greater preference for car commuting after the separation.

In the employment domain, the coincidence between housing and job changes did not shorten the commuting distance in all three SEM models. Inconsistent with the co-location hypothesis, this result indicates that the studied respondents did not treat residential relocation as a way to approach the workplace, or vice versa (similar longitudinal evidence provided by Prillwitz et al., 2007, and Beige and Axhausen, 2017). Moreover, simultaneous changes in housing and job locations prompted a switch to car use and AM use. Starting car commuting could arise from more income gained and extra cars purchased after job changes (Table 5). The switch to active commuting might relate to the gender difference because female respondents commuted shorter distances than male respondents following the relocation (Table 7). To test this, we constructed the interaction terms between gender and the event of job changes in Tables 5 and 7. The results support that when housing and job changes took place in the same year, women were marginally more likely to switch to AM and less likely to switch to car for commuting (only at the significance p between 0.10 and 0.20), suggesting their tendency of working closer to home and active commuting to work (Tao et al., 2023).

Changes in household car ownership and spatial contexts pre-post relocation also depended on their baseline statuses at pre-relocation. As for the results of baseline car ownership, respondents from car-owned households tended to move away from the urban region and the train station. Accordingly, they were inclined to switch to car for commuting but less likely to start PT use after the relocation. This suggests that car availability undermines the importance of residential built environment for relocation decision-making, which contributes to greater car dependence in the household. In line with the evidence from other longitudinal studies (Scheiner and Holz-Rau, 2013; Van de Coevering et al., 2016), the baseline values of built environment characteristics and the commuting distance were negatively associated with their respective *change* values pre-post residential relocation. For example, a long distance to the centre of an urban region at pre-relocation was predictive of a decline in that distance following the relocation, substantiating the phenomenon of regression towards the mean in longitudinal research (Campbell and Kenny, 2002).

Besides the significant results of gender and household income as stated before, there were two age groups with the potential of increased car use. Compared with the respondents aged below 30, those aged 30–39 were more likely to increase household car numbers, prefer not to commute by PT, and avoid switching to active commuting after residential relocation. Despite expressing an aversion to car use, respondents aged between 50 and 69 tended to move farther from the urban region and acquire more cars in the household, which entailed and enabled the long-distance car commuting trips.

6. Discussion and conclusions

Residential self-selection research has been arguing for the role of changes in built environment versus pre-existing travel attitude in (re)shaping travel behaviours. Our study contributes to this self-selection argument by integrating it into a wider scope of the interrelation with life events and recognising the temporal variations in travel attitude pre-post residential relocation. Following a longitudinal research design and a socio-spatial contextual approach, we have investigated how commuting mode choices and preferences are causally influenced by residential built environment and job-housing relationships on the one hand, and by the coincidence between relocation events and other family- or job-related life events on the other hand. Our findings indicated residential self-selection specifically for people who preferred commuting by car and public transport before the relocation. By contrast, the reverse causality from the built environment to mode-specific preferences was established for the preference for active commuting at post-relocation. Moreover, family- and job-related life events (e.g., childbirth and job changes) often coincided with the relocation event and predisposed the choices of residential locations, which jointly contributed to greater demand for car use and imposed additional barriers for promoting sustainable commuting behaviours.

Given that travel attitude is time-varying pre-post residential relocation, our study found not only residential self-selection but also reverse causality at play in the relationships between built environment, commuting mode choices and mode-specific preferences. Examining these two effects in an integrated framework is hardly achieved by the retrospective research design that only measures travel attitude at post-relocation, nor by the quasi-longitudinal design that simply investigates attitudinal changes pre-post relocation. In this regard, the only longitudinal evidence is from Beijing, China, where the effect of residential self-selection was limited due to constrained housing markets, but residents' preference for active travel modes significantly improved after they moved to a more urbanised neighbourhood (Wang and Lin, 2019). Our large-scale longitudinal analysis in the Netherlands, however, shows that the extent to which residential self-selection and reverse causality took effect was specific to the commuting mode of interest. For the active commuting preference, there was little residential self-selection but clear evidence of reverse causality. In other words, active commuting lovers were incapable of or did not think about changing houses to satisfy their pre-existing travel preferences. To alleviate the behaviour-attitude inconsistency (De Vos and Singleton, 2020; De Vos, 2022), they would adjust downwards their favourable stance toward active commuting once moving away from the urban region with increased commuting distances and worse accessibility to high-quality public transport. By contrast, we did find the self-selection for people who appreciated using motorised means of

transport for commuting. Particularly, car lovers were inclined to move to more suburban areas and acquire additional cars to cover longer-distance commuting trips, while public transport lovers would take the initiative to relocate to a place with an easier access to the intercity train.

The second important contribution of our study is introducing life events in the household and employment domains to better understand the relationships between changes in built environment and changes in commuting behaviours. Previous studies on travel-related changes focused more on the independent effects of relocation events and other events in life (e.g., Clark et al., 2016; Beige and Axhausen, 2017; Whittle et al, 2022). These studies overlooked the fact that residential relocation is often an adaptation consequent to the occurrence of another life event. After these structural transitions in life, people's travel demands and preferences would vary from the situation before (Scheiner, 2014; Müggenburg et al., 2015). Using family- and job-related life events as a surrogate for people's immediate social contexts in personal and family life, our results support that three concurrent life events in the household domain were related to greater car use or preferences. Specifically, childbirth increased car numbers in the household and stimulated car use for commuting. Cohabitating with the partner led to longer commuting distances that entailed car use, while separating with the partner would develop a preference for car commuting. In addition, evidence on the co-location between home and the workplace was less clear and the resultant commuting mode shift is likely to present gender differences (similar household-level longitudinal evidence provided by Tao et al., 2023). Another intriguing finding is that two age groups, namely those in their thirties and fifties or sixties, had the potential of switching to more car-oriented commuting patterns regardless of the occurrence of life events.

Based on these main findings, our study offers policy implications for urban transportation planning and travel demand management aimed at spreading sustainable commuting patterns among a wider range of working populations. Our pre-post analysis of the relocation event lends support to the structural role of spatial contexts in (re)shaping people's commuting mode choices and preferences above their prepositioned socio-economics and travel-related attitude. As such, policy initiatives, such as the transport-oriented development, walkable neighbourhoods and smart urban growth, deserve to be advocated for allowing the self-selection into the neighbourhood friendly to transit/active transportation, as well as encouraging the preference transition to these sustainable travel modes and enhancing their future use. Specific to each commuting mode under study, a number of people could not find a suitable house to walk or cycle to work even though they desired to do so. Apart from alleviating the job-housing mismatch within the urban region, flexible workplace settings (e.g., working closer to home at satellite offices or neighbourhood business hubs; Beck and Hensher, 2021) and widespread e-bicycle use are also promising ways to reduce spatial barriers for active commuting. Considering the strong residential self-selection to satisfy the car commuting preference, we suggest policy initiatives target those carless households and neighbourhoods with fewer car enthusiasts. Another viable way is by making alternative commuting modes more attractive around the neighbourhood. As shown by our results, an easy-access and high-quality public transport system is a countermeasure for extended commuting distances and increased car use following the relocation. Furthermore, weakening people's preference for car commuting, such as through educational campaigns on environmental awareness and company-led programs of active/transit commuting to work, is helpful to discourage car use in everyday life and influence the long-term decision on residential locations.

Notably, the policy implications abovementioned should not leave behind the social context of residential relocation and heterogeneous travel demand and preferences for people at different life stages. To promote sustainable ways of travelling, we recommend policy designs targeting and being tailored to those potential car users before their major changes in life. Two age groups of particular interest are commuters in their early adulthood who are undergoing frequent changes in family circumstances and job-housing relationships, and those middle-aged commuters who relocate away from the urban region prior to their retirement. Given their tendency to start car use or enhance car preferences after the relocation, additional intervention strategies, such as targeted information on sustainable travel alternatives for housing-seeking families and trial mobility packages combining free public transport tickets and bike sharing offers, are required to postpone or even reverse their car-dominant commuting patterns in the near future.

There are also some limitations in our study and relevant suggestions for future research. First, we relied on a two-wave panel dataset pre-post residential relocation to investigate changes in commuting mode choices and mode-specific preferences pre-post residential relocation. Especially, our pre-post analysis focused on the impact of commuting mode shift on mode-specific preferences at post-relocation after controlling for pre-relocation mode preferences, which leaves the reverse effect of mode preferences on mode choices out of consideration. For this, the follow-up research (Tao, forthcoming) uses multi-wave prospective surveys (i.e., three survey waves respectively before the relocation, immediately after the relocation, and a period of time after the relocation) and advanced panel models (i.e., cross-lagged panel models) to examine the reciprocal relationships between travel behaviours and attitude over time. Second, we used the mode-specific preference in the annual MPN surveys as a proxy for the overall attitude towards certain commuting modes. This single-item binary measure simplifies the understanding of multiple underlying attitudes attached to different travel modes, and does not account for the measurement errors of mode-specific preferences. Third, extrapolating our findings from travel mode switch (e.g., switching to car use) to the situation of travel mode disposal (e.g., giving up car use) should be done with caution. A case in point is that changes in car use are likely to be asymmetrical; that is, once the car-use habit is established, it is difficult to roll back (Scheiner, 2007; Clark et al. 2016). If so, our study on the mode switch behaviour is of particular importance because it is relevant to discouraging car use in the first place. Fourth, our research evidence on the gender difference in commuting behaviours is tentative. For drawing more robust conclusions, we recommend using matched panel samples of couples to study how they allocate their job-housing relationships and commuting mode use at the time of relocation decision-making, and how these gender differences are varying across different life stages.

As one of the very few studies using real panel data pre-post residential relocation, our study provides additional insights into the longitudinal relationship between changes in socio-spatial contexts, travel behaviours and travel-related attitude. Echoing the habit-discontinuity hypothesis, residential relocation triggers people to deliberately think about their habitual commuting behaviours as well as pre-existing travel preferences. However, the magnitude and direction of changes in commuting mode choices and preferences

depend on the socio-spatial contexts of residential relocation and are specific to the commuting mode of interest. To better understand the relocation decision-making and resultant travel-related changes, residential relocation should be conceived as a process in the household context where the interrelated decisions on residential locations and travel behaviours are embedded in the long-term process of individual and family lives.

CRediT authorship contribution statement

Yinhua Tao: Conceptulization, Formal analysis, Writing – original draft. developed the research idea. **Ana Petrović:** Supervision, Writing – review & editing. **Maarten van Ham:** Supervision, Writing – review & editing. **Xingxing Fu:** Methodology, Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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