

Changes in Travel Behaviors of Life Stage Relative to Period and Generation

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Abstract: It is well known that travel behavior changes with the life stage. However, even in the same life stage, when considering the time axis, the travel behavior may change. In order to explain this change, we introduced two concepts "period" and "generation" and examined how the travel behavior changes due to factors of "period" and "generation", using the Tokyo Metropolitan Area (TMA) Person trip(PT) survey which were conducted continuously every 10 years from 1968 to 2008. We were able to show, in view of broader temporal changes and generational changes, that (1) people's work styles have changed as communication technology has advanced, (2) males are contributing to housekeeping, shopping, and raising children due to the increase in dual-income families, (3) seniors are becoming healthier and are more active as medical care advances, (4) the generation that was young during the period of high economic growth (baby boomers) are active.

Keywords: Life Stage, Generation, Period, Person Trip Survey, Travel Behavior, Tokyo Metropolitan Area

1. INTRODUCTION

In Japan, person trip (PT) surveys were first conducted in the 1960s and were primarily done for research purposes. The first extensive PT survey in Japan was conducted in the Hiroshima Metropolitan Area in 1967. In the TMA, a PT survey has been conducted every ten years since 1968. The TMA is exceptionally rare in metropolitan areas worldwide, in that extensive PT surveys have been conducted consistently for such a long period of time.

In the Tokyo Metropolitan Area (TMA), beginning with the period of high economic growth that began after the end of World War II, the use of personal transportation rapidly increased in the general public. Following this trend, lifestyles and methods of engaging in industrial activities have changed significantly while the metropolitan area continued to grow. However, at present, not even the TMA is an exception from the country's general trend of an

aging population and a falling birthrate. Populations are already decreasing in suburban areas of the TMA. As a result of a growing diversification in lifestyle, the large population of active seniors in the TMA, due to the growth in healthy life spans and the preference of the young not to drive themselves or go out frequently, travel behaviors have significantly changed.

The TMA is the world's largest area by population; its travel demand is also the greatest in the

world. For this reason, it is of great importance to understand the changes it has witnessed and their causative factors to predict future travel behaviors in the medium to long run, in relation to expected changes in the social and economic situation, including those that are due to the trends of the aging population and the declining birthrate, which are expected to continue into the future, and by this means determine what political measures can be taken and develop policies in response.

2. SUMMARY OF THE TMA PT SURVEYS

2.1 Summary of the PT Surveys

Table 1 gives a summary of the TMA PT surveys. In 1968, the first survey was conducted in the Kanagawa, Saitama (excluding Chichibu), and Chiba (excluding Boso) regions of Tokyo. As commutable areas expanded, the second survey, conducted in 1978, was expanded to examine all regions of the metropolis and the three bordering prefectures, i.e., Tokyo, Kanagawa, Saitama, and Chiba, as well as the southern part of the Ibaraki prefecture. In the fifth survey, the extent of the southern part of Ibaraki surveyed was expanded. As the survey expanded and the population of the TMA increased, the population within the areas covered by the PT survey also increased, from 21.31 million under the first survey to 34.62 million in the fifth, about a 1.6-fold increase. The surveys reached about 2% of the metropolitan population, i.e. 0.5–0.8 million people.

Table 1. Summary of Tokyo Metropolitan PT surveys

	First Survey	Second Survey	Third Survey	Fourth Survey	Fifth Survey
Survey Year	1968 (S43)	1978 (S53)	1988 (S63)	1998 (H10)	2008 (H20)
Surveyed Areas	Tokyo, Kanagawa, Saitama (excluding Chichibu) and Chiba (excluding Boso)	Tokyo, Kanagawa, Saitama, Chiba, Southern Ibaraki	Tokyo, Kanagawa, Saitama, Chiba, Southern Ibaraki (including Kashima)	Tokyo, Kanagawa, Saitama, Chiba, Southern Ibaraki (same as the third survey)	Tokyo, Kanagawa, Saitama, Chiba, Southern Ibaraki (adding the cities of Omitama and Namegata)
Population of the TMA	21.31 million	28.77 million	32.49 million	34.47 million	34.62 million

Sample Rate		2.0%	2.4%	Civic center, Outer periphery 1% Outer Tokyo wards 2% Other 3%	Tokyo wards 1.96% Other 2.85%	Tokyo wards 1.90% Ordinance- designated cty 2.53% Other 2.85%
Survey Method	Distribution	By visits	By visits	By visits	By visits	By mail
	Collection	By visits	By visits	By visits	By visits	By mail and web
Collection Rate		86.7%	84.9%	81.5%	71.5%	25.6%
Number of Samples(Valid Data)		0.315 million	0.588 million	0.668 million	0.883 million	0.735 million
Number of Trips (Expanded)		48.3 million trips	67.0 million trips	74.3 million trips	79.0 million trips	84.9 million trips
Use Rate Transportation	Public Transportation	31.5%	26.5%	27.9%	27.8%	32.8%
	Automobiles (including motorcycles)	19.8%	26.8%	30.5%	35.3%	31.2%
	Walk (including bicycles)	48.7%	46.7%	41.6%	36.9%	36.0%

3. EXISTING RESEARCH

Person's life is caught with a life course, and there are a lot of studies which analyzed how travel behavior changed by the life event, for example getting a job, marriage, a movement and the first child birth which occurs during a life course. The panel research about which we question an identical person in more than one points is needed to do such analysis.

Ben Clark et. al., show that a life event, the space situation and the attitude for the environment hard using the panel data as of British(UKHLS(2009/10 and 2010/11).

Joachim Scheiner et. al., analyzed what kind of influence an important event in a life course had on use of travel mode. And they show that when individual data is aggregated a change in the use mode seems stable, but many life events lie in its back and that mode use sometimes changes by other factor changes even if there are no important life events.

It's studied using biography data as something substituting of panel data to have to question an identical person many times a long period.

Kiron Chatterjee et. al., is talking on the validity of the biography approach to grasp the influence by which a life event gives it to travel behavior.

Sigrun BEIGE et. al. analyzes a relation between long mobility and middle mobility using the biography data which performed in Zurich, and shows that middle mobility is related to long mobility each other.

On the other hand, there are few cases which did a change analysis of travel behavior using panel data and biography data in Japan. There is accumulation of more than one point of PT survey data at many metropolitan areas in Japan, and the study such as aggregating data according to the life stage and comparing the travel characteristic is the most part.

As an analysis using time series data, there is an approach that captures three effects by age, period, and cohort.

A classic article by Kermack et. al is an early use case of cohort analysis, and studies of different mortality rates by cohort have been conducted, incorporating the concept of APC(age, period and cohort). Since then, various studies have been conducted in the medical and demographic fields, but the number has been limited in the transportation field.

Looking at some cases in the transportation field, analysis methods include cross-tabulation plotting and statistical methods. When using the statistical method, there is a problem that the three effects of age, period, and cohort are interdependence to each other, so each effect cannot be uniquely identified.

Siren et al. analyze how travel patterns differed among cohorts using Denmark's National Travel Survey. In particular, statistical methods are not used, and differences between cohorts are expressed by plotting.

Sarah et. al. analyze empirically whether there is a cohort difference, baby boomers and present elderly on the elderly's trip by cohort analysis. The parameters were estimated by discrete model and joint continuous / discrete model using NPTS data of 4 time points, and travel volume of future elderly people was estimated, and it was shown that there is a cohort effect.

Yilin et al. confirmed that there is an automobility cohort by the Age-Period-Cohort-residential area (APCRA) model, using data from four time points in the Keihanshin metropolitan area. But, since the 4 effects are treated as independent, the study considering the interdependence of the 4 effects is for further study.

Looking at the cases of research in Japan, there are few cases in which changes in travel behavior were analyzed using panel data and biomedical data. However, many urban areas in Japan have accumulated PT survey data at multiple points, and there are many studies that use this data to summarize data by life stage and compare travel characteristics, but there is little studies using statistical methods

Endo et al. examined whether lifestyle (taking the nighttime activity rate as an indicator) changed between generations (cohorts), periods, and/or life stages and what factors contributed to changes in travel behavior (using car use ratio as example), owe to the belief in the importance of enabling the evaluation of transport policies through travel behavior analysis that incorporates lifestyle factors such as the living customs in an aging society. However, these studies have not been developed to the extent that they can be used to analyze the relevance of lifestyles to travel behaviors.

Sugita et al. indicated how travel behaviors can vary, depending on the environmental factors surrounding an individual (e.g., family structure and vehicle ownership) and how travel behaviors have changed with period, using data on the TMA from PT surveys of 1978 and 1988.

Morio et al. found decreases in car ownership intensity, therefore in both car use intensity and the car use rate among the young, and decreases in car use intensity for business purposes among residents of the ward areas of Tokyo, and for work and business purposes for residents in areas that are 30 km or further from the metropolitan center, using the PT survey data on the TMA from 1988 and 2008.

Fujioka et al. analyzed the travel behaviors of young females (20-39-years olds) in relation to different lifestyle, workstyle, and car ownership situation for each life stage, using the PT survey data on the TMA from 1998 and 2008. In particular, they analyzed the differences of activities on a particular weekday and differences in car use. They confirmed that the use of cars was not decreasing in households with children, but the use of cars was decreasing in the households of childless married couples.

Doi et al. analyzed changes in the travel behaviors of the young generation (in their 20s and 30s) and forecasted the change of their travel behaviors, using data from the PT surveys of the Kyoto–Osaka–Kobe (referred to as Keihanshin) Metropolitan Area conducted in 1990, 2000, and 2010. And they confirm that the decrease in the number of trips will outstrip the trend if the trends of activity decreases in young generation continue. Furthermore, in order to investigate the background of decrease in production intensity, a web questionnaire survey was conducted with the aim of grasping the situation of people who do not go out.

Nishihori et al. focused on 30- to 34-year-olds, the group with the greatest drop in production intensity, and analyzed trip chains and the number of trips, by attributes such as their occupations and household structure, from the 2000 and 2010 PT survey data of the Keihanshin Metropolitan Area. They found that the unemployment person with living their parents had greater decreases in the number of trips, and decrease in people who make multiple trips is large.

Morio et al. analyzed the influence of improving transportation facilities on travel behaviors, using the data from the PT surveys data of the TMA from 1968, 1978, 1988, 1998, and 2008. And they observed changes in the travel behavior of Nagareyama, a suburb of the TMA by the Tsukuba Express, which opened in 2005.

It is well known that travel behavior changes with the life stage. However, even in the same life stage, when considering the time axis, the travel behavior may change. In order to explain this change, we introduced two concepts "period" and "generation" and examined how the travel behavior changes due to factors of "period" and "generation"

4. Framework of Our Study

4.1 Mechanism of Determining Travel Behaviors

We assumed the determination mechanism for travel behavior as shown in Figure 1. People select activities that are necessary for individuals and families, and allocate activities in the time frame such as 24 hours. The result becomes appears as travel behavior. The selection of activities and time allocation is different depending on the life stage, social system/technology and values (lifestyle), and it varies according to the situation in where the person is located.

When introducing the concept such as the life stage as the situation where the person is located it can be easily classified into relatively homogeneous groups. However even those who belong to the same life stage are influenced by the period, that is, the social system/technology situation, and even the values that person possesses. Values are people's way of living, diverse, complex. Therefore it is very hard to grasp. However introducing concepts such as "generation", for example "baby boomer generation", it is easy to grasp a relatively homogeneous groups. With this in mind, we analyzed the factors behind the changes in travel behavior, taking into account the concept of "period" and "generation", centered on the "life stage".

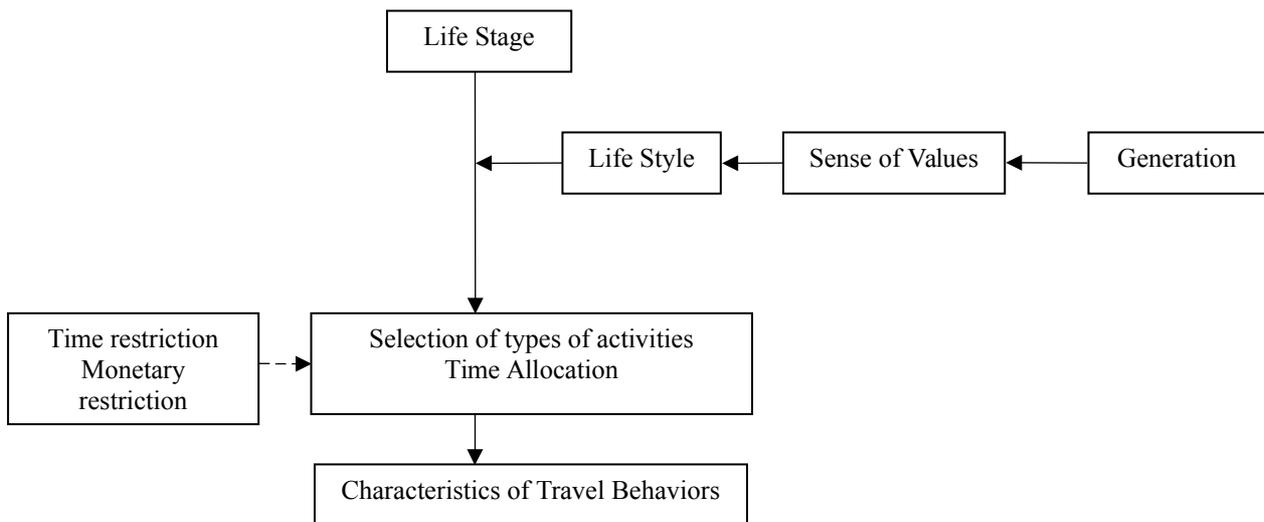


Figure 1. Determination mechanism for travel behaviors

4.2 Analytical Methods

Using age groups as an index for grouping data into similar life stages, we conduct two analyses: "(1) a chronological analysis of travel behaviors of same age groups (Figure 2.)", "(2) a chronological analysis of travel behaviors of same generations. By (1)'s analysis we can grasp the influence on the travel behaviors by the difference of the period, and by (2)'s analysis we can grasp the influence of the generation differences on the travel behaviors in addition to difference of the period. Indexes created to understand the characteristics of travel behaviors may include rate of leaving home, number of trips (number of trips per person), trip purpose, destination, trip length, means of transportation used, and time of trip occurrence. In

this paper, to understand the changes in characteristics of travel behaviors over the entire TMA, we conducted our analysis while limiting the focus to going-out rate, number of trips (number of trips per person), and trip purpose.

	1968	1978	1988	1998	2008
10s	$X_{t,i}^{k}$	$X_{t,i}^{k}$	$X_{t,i}^{k}$	$X_{t,i}^{k}$	$X_{t,i}^{k}$
20s	$X_{t,i}^{k}$	$X_{t,i}^{k}$	$X_{t,i}^{k}$	$X_{t,i}^{k}$	$X_{t,i}^{k}$
30s	$X_{t,i}^{k}$	$X_{t,i}^{k}$	$X_{t,i}^{k}$	$X_{t,i}^{k}$	$X_{t,i}^{k}$
40s	$X_{t,i}^{k}$	$X_{t,i}^{k}$	$X_{t,i}^{k}$	$X_{t,i}^{k}$	$X_{t,i}^{k}$
50s	$X_{t,i}^{k}$	$X_{t,i}^{k}$	$X_{t,i}^{k}$	$X_{t,i}^{k}$	$X_{t,i}^{k}$
60s	$X_{t,i}^{k}$	$X_{t,i}^{k}$	$X_{t,i}^{k}$	$X_{t,i}^{k}$	$X_{t,i}^{k}$
70s	$X_{t,i}^{k}$	$X_{t,i}^{k}$	$X_{t,i}^{k}$	$X_{t,i}^{k}$	$X_{t,i}^{k}$
80s	$X_{t,i}^{k}$	$X_{t,i}^{k}$	$X_{t,i}^{k}$	$X_{t,i}^{k}$	$X_{t,i}^{k}$

Figure 2a. Illustrative diagram of chronological tracking by age group

	1968	1978	1988	1998	2008
10s	$X_{t,i}^{k}$	$X_{t,i}^{k}$	$X_{t,i}^{k}$	$X_{t,i}^{k}$	$X_{t,i}^{k}$
20s	$X_{t,i}^{k}$	$X_{t,i}^{k}$	$X_{t,i}^{k}$	$X_{t,i}^{k}$	$X_{t,i}^{k}$
30s	$X_{t,i}^{k}$	$X_{t,i}^{k}$	$X_{t,i}^{k}$	$X_{t,i}^{k}$	$X_{t,i}^{k}$
40s	$X_{t,i}^{k}$	$X_{t,i}^{k}$	$X_{t,i}^{k}$	$X_{t,i}^{k}$	$X_{t,i}^{k}$
50s	$X_{t,i}^{k}$	$X_{t,i}^{k}$	$X_{t,i}^{k}$	$X_{t,i}^{k}$	$X_{t,i}^{k}$
60s	$X_{t,i}^{k}$	$X_{t,i}^{k}$	$X_{t,i}^{k}$	$X_{t,i}^{k}$	$X_{t,i}^{k}$
70s	$X_{t,i}^{k}$	$X_{t,i}^{k}$	$X_{t,i}^{k}$	$X_{t,i}^{k}$	$X_{t,i}^{k}$
80s	$X_{t,i}^{k}$	$X_{t,i}^{k}$	$X_{t,i}^{k}$	$X_{t,i}^{k}$	$X_{t,i}^{k}$

Figure 2b. Illustrative diagram of chronological tracking by generation

5. ANALYSIS OF CHANGES IN CHARACTERISTICS OF TRAVEL BEHAVIORS OVER 40 YEARS

5.1 Characteristics of Travel Behavior Analysis with Chronological Monitoring of Same Age Group

a) Changes in rates of leaving home

If we look at the changes from the 1978 to 2008 surveys according to age groups, we can see large increases in the rate of people who went out during the day (rate of leaving home), in the groups of respondents 50s and older for the both males and females (Figures 3 and 4). Here, in the first PT survey, those who did not leave home are excluded from the count. Because we could not determine the rates of leaving home from this survey, its data were excluded from the comparison.

These increases could have occurred due to the longer lifespans and increase in the numbers of healthy seniors that are owing to advancements in medical technology; males'

average life span increased from 69.3 years (1970) to 79.6 years (2015), and in females, the average life span went from 74.7 years (1970) to 86.3 years (2010).

In addition, our examination of the changes in going-out rate among those 20–29 years old revealed two points of decrease in the males and three points of increase in the females, an opposing trend between the sexes. This pattern could be explained for by the increases in the unemployed and increases in the number of stay-at-home individuals who find the advancement of communication technologies to reduce their need to leave home, otherwise by the increase in the female working population.

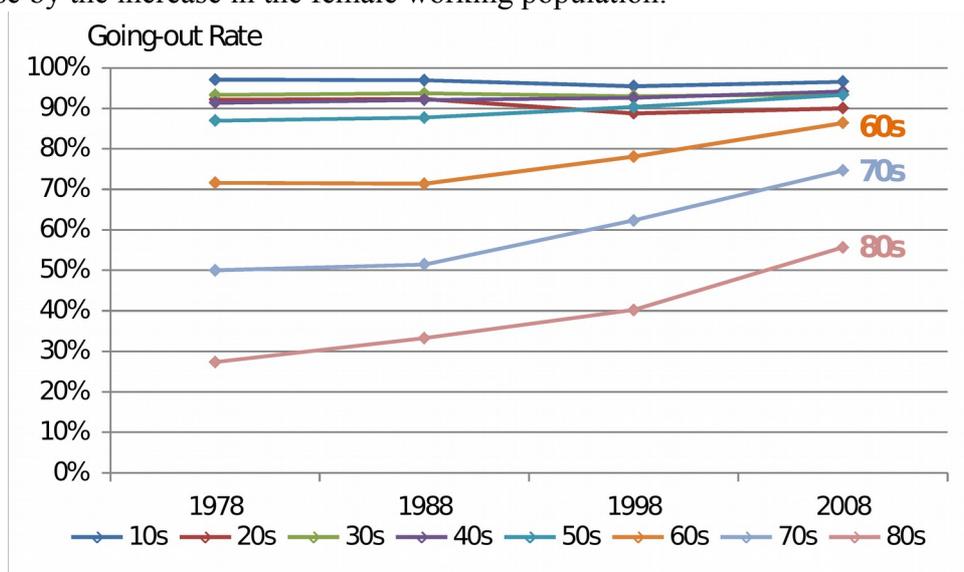


Figure 3. Transition in rates of leaving home by age groups (males)

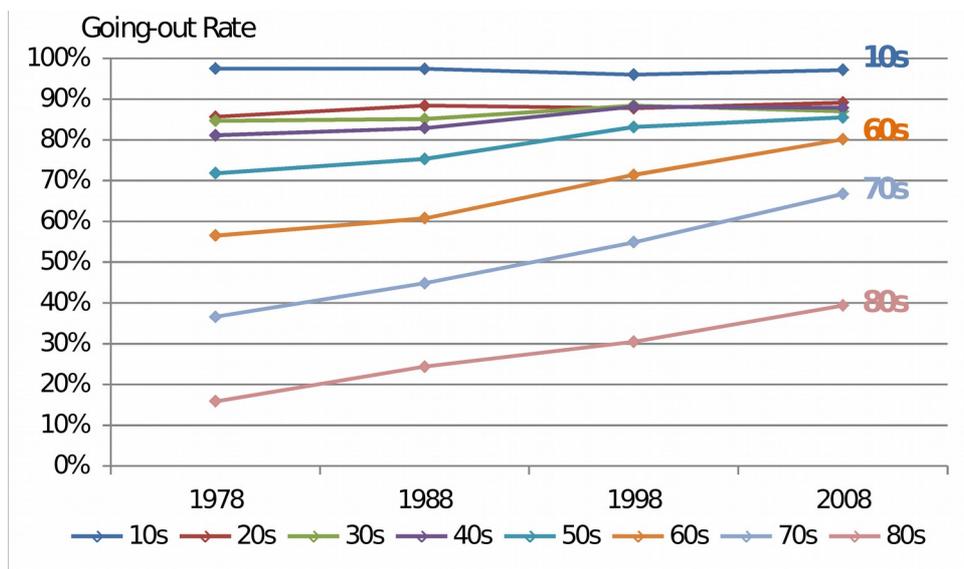


Figure 4. Transitions in rates of leaving home by age group (females)

b) Changes in net production intensity

We examined the change in the number of trips per day per person who left home (net production intensity) from 1968 to 2008. We found an increase of 0.3 trips/person/day among

males from 60 to 69 years old, there was a decrease of 0.4–0.6 trips/person/day among young people between 20 and 39 years old. In addition, while there was an increase of about 0.2–0.3 trips/person/day in females from 60 to 69 years old, a decrease of about 0.2–0.3 trips/person/day was found in people from 20 to 39 years old (Figures 5 and 6).

c) Changes in travel behaviors among those aged 10–29 years

We plotted going-out rate as the ordinate and Number of trips per person as the abscissa (Figures 7, 9, 11, 13, 15, and 17). Through our factorization of gross intensity into going-out rate and number of trips per person like this, we were able to capture the changes visually. We also showed number of trips per person and its

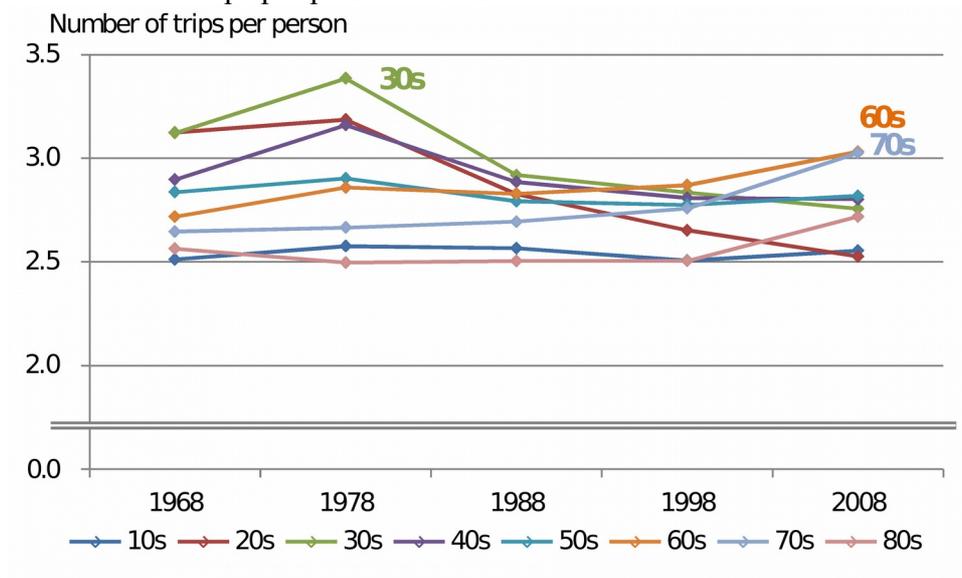


Figure 5. Transition in number of trips per person by age groups (males)

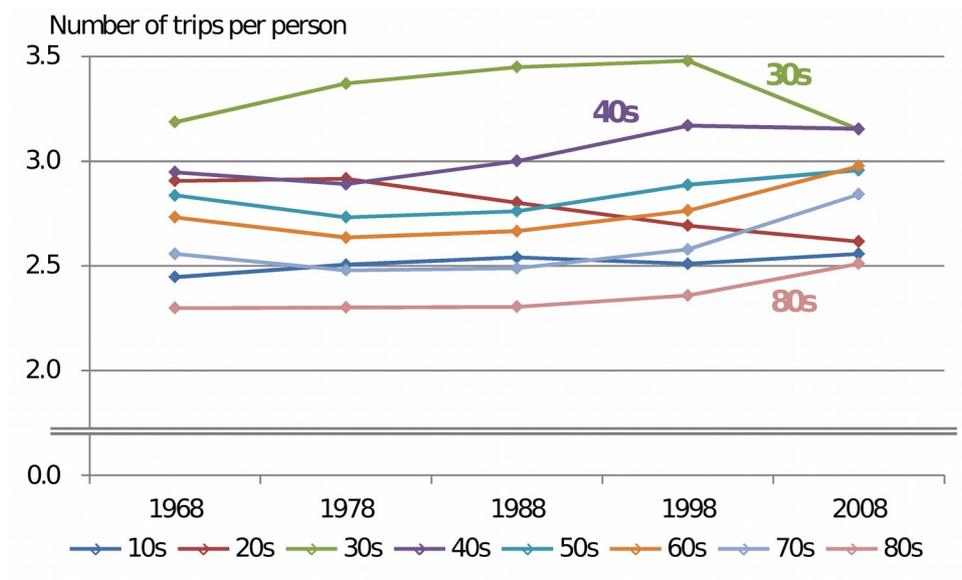


Figure 6. Transition in number of trips per person by age groups (females)

changes in a two axis chart by trip purpose. (Figures 8, 10, 12, 14, 16, and 18). The left axis and right axis illustrate Number of trips per person and the amount of change of Number of trips per person by trip purpose, respectively. Number of trips per person is illustrated using a line graph, and the year 1978 is categorized by trip purpose and illustrated with a bar graph. For the years 1988, 1998, and 2008, the bar graph shows the amount of change in the trip purpose-specific intensity over the preceding 10 years.

For the age group of 10–19 years old, no change was observed in going-out rate or Number of trips per person for either males or females, and their travel behaviors did not change. However, work trips decreased, but school trips increased (Figures 8 and 10). The increasing population of college students in that age group may have contributed to this trend. For reference: men’s college admission rate increased from 22.0% (1968) to 55.6% (2016), and the women’s rate increased from 5.2% (1968) to 48.2% (2016).

Among males in their twenties, both going-out rate and number of trips per person decreased, but the decrease in intensity was greater than the decrease in going-out rate. The decrease in intensity may be due to the decrease in business trips (Figure 8). Up until 2008 (the fifth PT survey), the amount of face-to-face work decreased as advancements in communication technologies, such as the fax, mobile phones, internet, and smartphones developed. We consider that the decreases were significantly affected by changes in work styles. For females in their 20s, decreases in their net production intensity are generally smaller than the changes that took place for the males. Although their work trips increased, their personal trips decreased more than the increased work trips, which resulted in a net decrease in intensity (Figure 10). The increases in the work trips are due to increases in the numbers of working females; we guess that the decreases in free time among women occurred as a result of their increase labor, which then contributed to the decrease in personal trips.

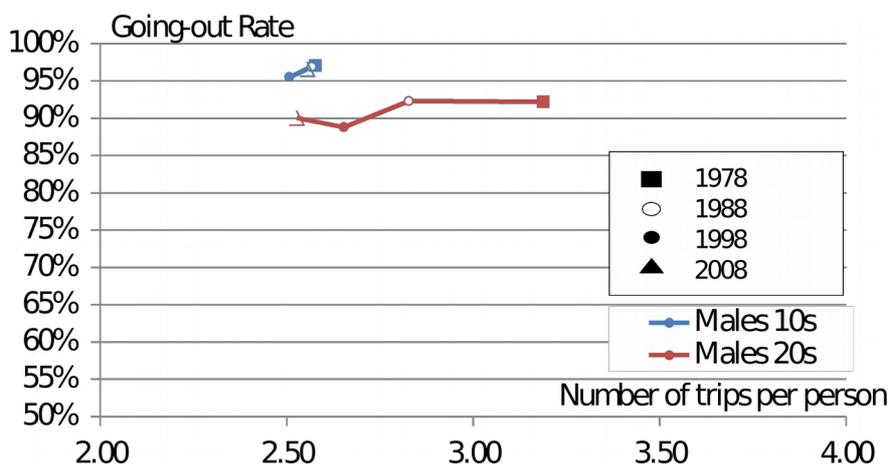


Figure 7. Changes in going-out rate and number of trips per person of young males

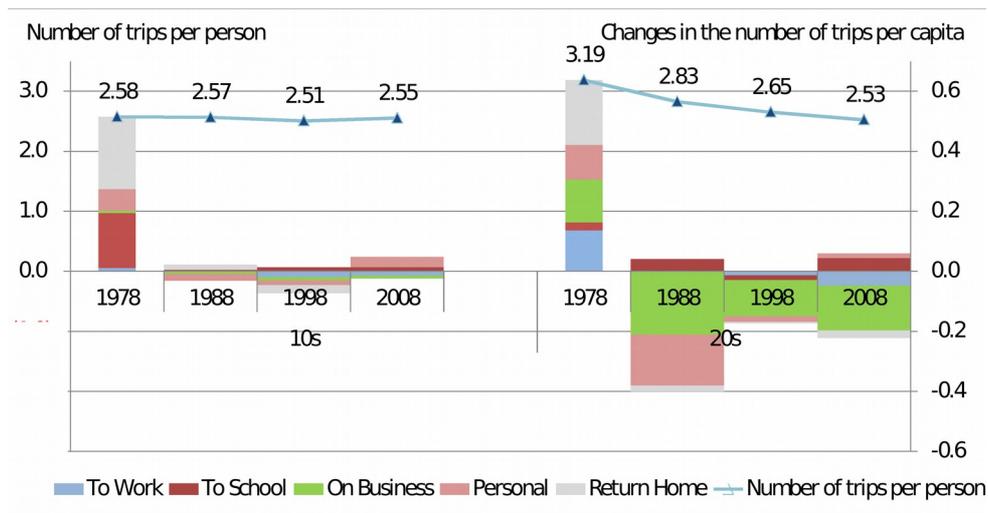


Figure 8. Changes in number of trips per person of young males by purpose.

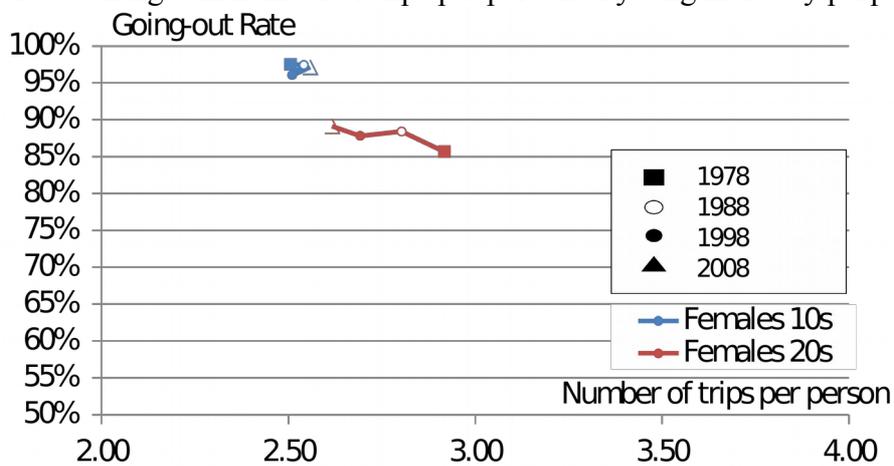


Figure 9. Changes in going-out rate and number of trips per person of young females

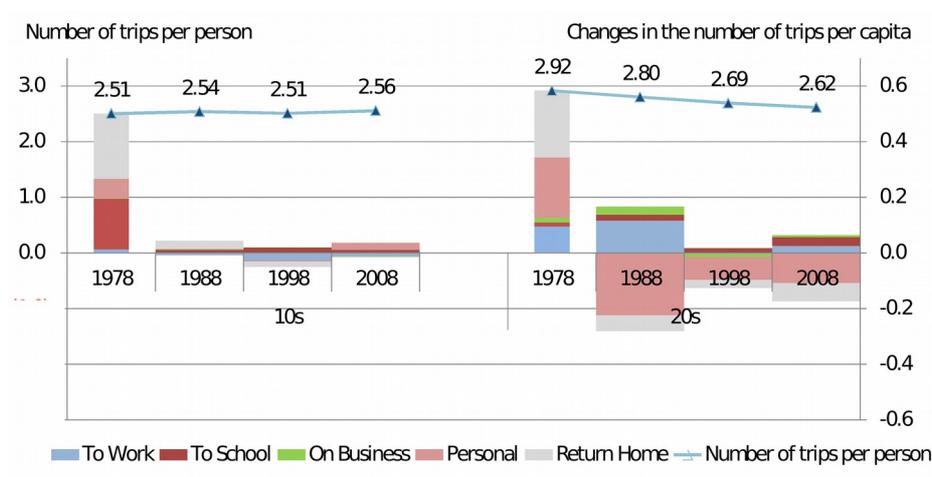


Figure 10. Changes in number of trips per person of young females by purpose

d) Changes in the travel behaviors of middle-age groups (30–59)

The change of travel behaviors for males in their 30s and 40s are similar and for females in their 40s and 50s are similar (Figures 11 and 13).

Going-out rate among males from 30 to 39 years old changed little, and their net production intensity decreased. This may be because of decreases in business trips after the peak in such trips, which occurred in 1978 (Figure 12). As already seen in the changes in the travel behaviors of young people, these trends may be owing to the changes in work style as communication technologies advanced, requiring less face-to-face work. On the other hand, personal trips also increased slightly, which may also be interpreted as a reflection of the increase in numbers of males who began to contribute to housework, shopping, parenting (taking and picking their child/children to and up from kindergarten, e.t.c.) because of the increase in dual-income households. The late marriage has increased the unmarried rate of men in their thirties, while the number of double-income households is also steadily increasing. Also, the personal trips analyzed here include trips related to housework and parenting, as well as leisure trips, and in order to confirm the facts of the comments, the purpose of the personal trips is subdivided and the analysis deepens is necessary.

Some females from 30 to 39 years old, while their rate of leaving home and number of trips per person both increased till 1998, going-out rate and intensity both tended to decrease from 1998 to 2008. If we examine the changes in number of trips per person by trip purposes from 1998 to 2008, work trips were found to have increased, but beyond this increase, personal trips decreased (Figure 14). During those years, more people were planning their lives with the presupposition that they would live in a dual-income household. Thus, work trips increased. Because women's living environments changed, regarding marriage, working after marriage, parenting, and other features, the intensity of their personal trips changed, and the drop in personal trips from 1998 to 2008 is significant.

Males 40–49 years old exhibited similar travel behaviors to those of males from 30 to 39 years old. Females 40–49 years old exhibited increases in both going-out rate and net production intensity. As with females 20–39 years old, while their work trips increased, but their personal trips did not decrease as much (Figure 14).

Males 50–59 years old did not show as much change in their travel behaviors as males from 30 to 49 years old did. It should be noted that business trips by males from 50 to 59 years old did not decrease as much as those of males 30–49, and their personal trips increased (Figure 12). Men in their 50s, in general, have attained important posts at their company, which are attended with the need to engage in many face-to-face meetings. For this reason, their business trips appear to be less affected by advancements in communication technologies. However, females in their 50s, exhibited a larger amount of increase in their rate of leaving home than was seen for females in their 40s (Figure 13).

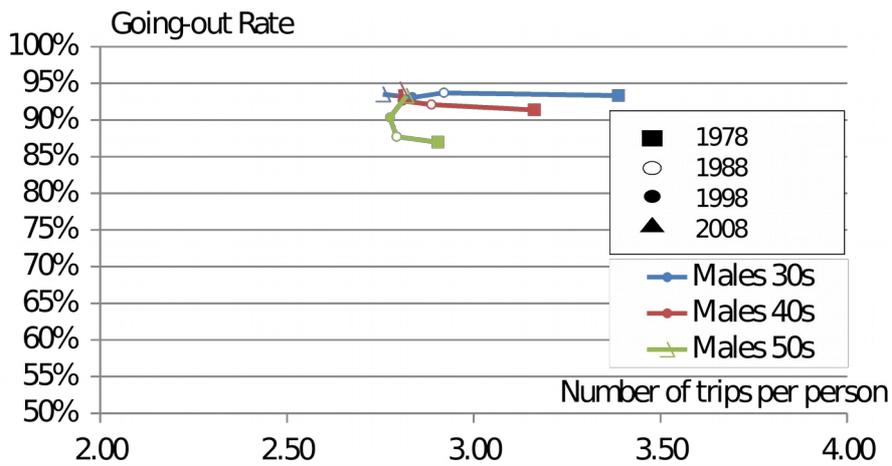


Figure 11. Changes in going-out rate and number of trips per person of early to late middle-age males

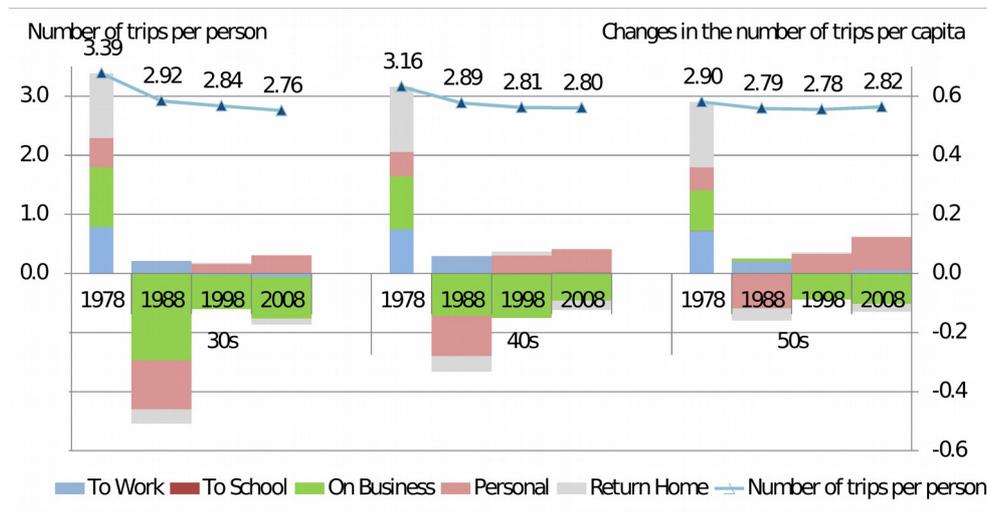


Figure 12. Changes in the number of trips per person of early to late middle-age males by purpose

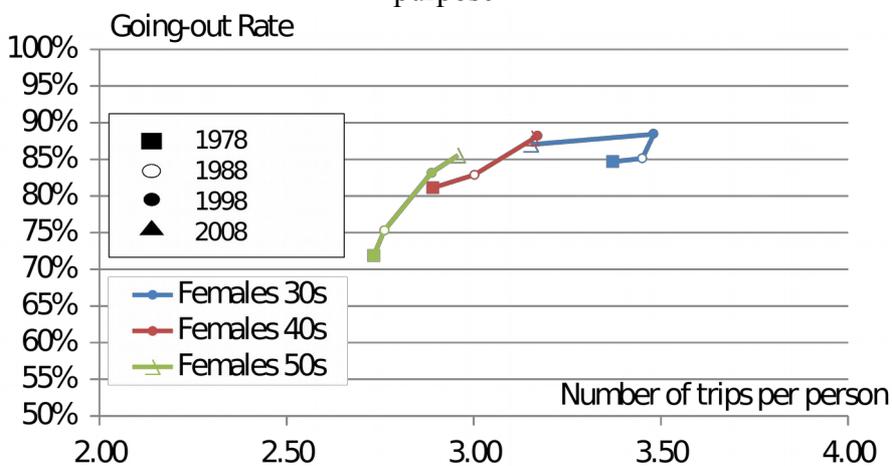


Figure 13. Changes in going-out rate and the number of trips per person of early to late middle-age females

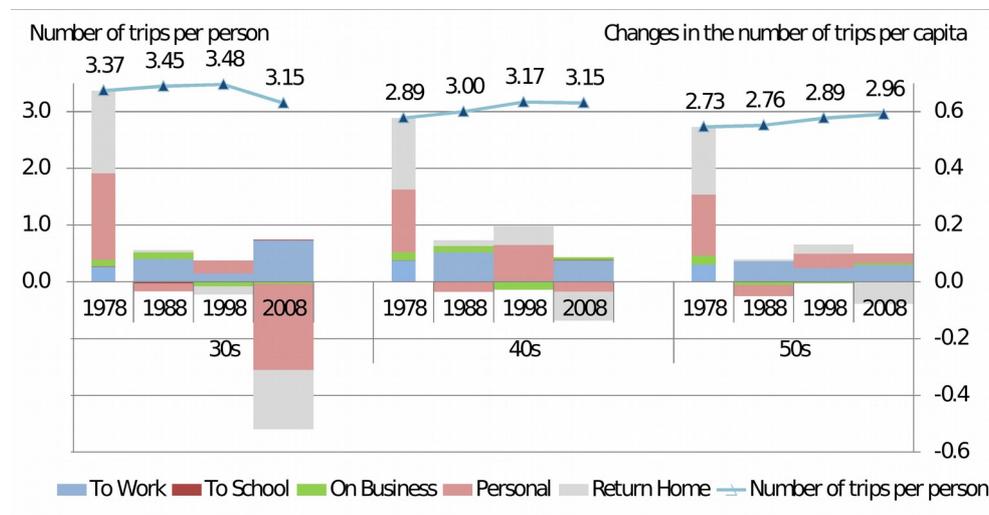


Figure 14. Changes in the number of trips per person of early to late middle-age females by purpose

e) Changes in travel behaviors of seniors (aged 60 years and older)

For seniors, aged 60 and older, going-out rate and number of trips per person are both increased in both males and females. In all senior age groups, personal trips increased (Figures 15, 16, 17, and 18).

For these groups in 1978 and 2008, their changes in behaviors matched the behaviors of age groups 10 years younger than them.

Males in their 60s had a certain number of business trips, and their trip intensities did not change much, but their personal trips increased (Figure 16). Females in their 60s had increases in personal trips and in their work trips (Figure 18).

Males in their 70s showed increases in personal trips, but work and business trips decreased. This may be because of the gradual decrease in working opportunities, such as the places of personally-owned stores and small factories in areas where they worked, regardless of old age (Figure 16). On the other hand, females in their 70s did have some business trips, but most of their trips were for personal trip purpose, and these also increased (Figure 18).

Males in their 80s had percentages of work trips and business trips decreased as males in their 70s (Figure 16). On the other hand, females in their 80s had trips that were mostly for their own personal activities, and these showed an increase (Figure 18).

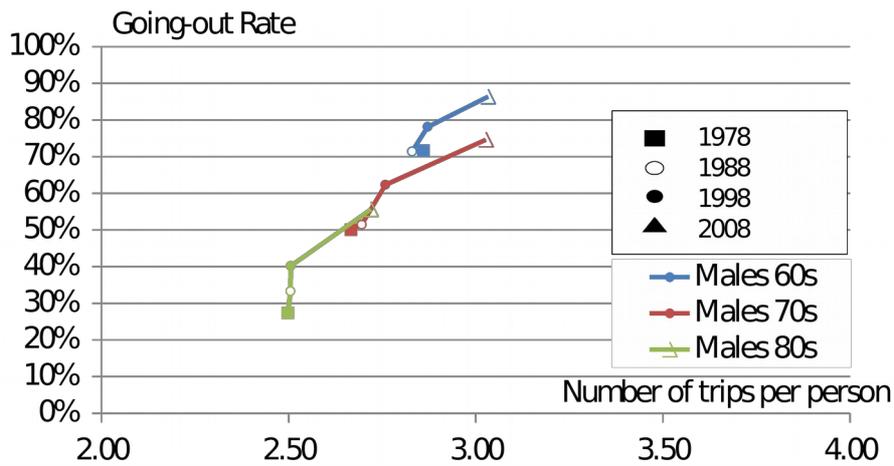


Figure 15. Changes in going-out rate and number of trips per person of senior males

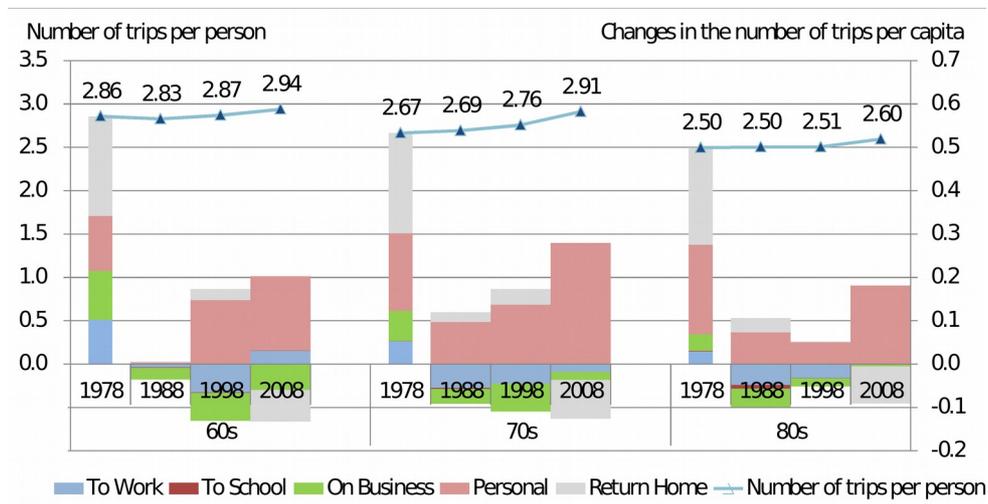


Figure 16. Changes in Number of trips per person of senior males by purposes

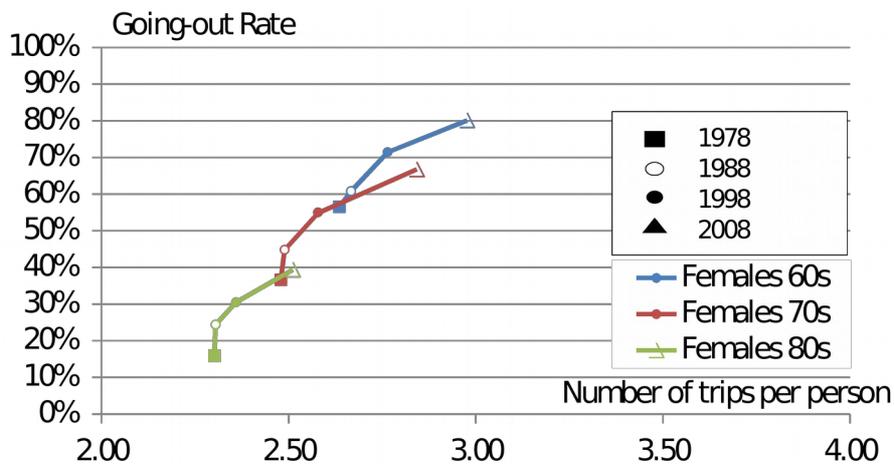


Figure 17. Changes in going-out rate and number of trips per person of senior females

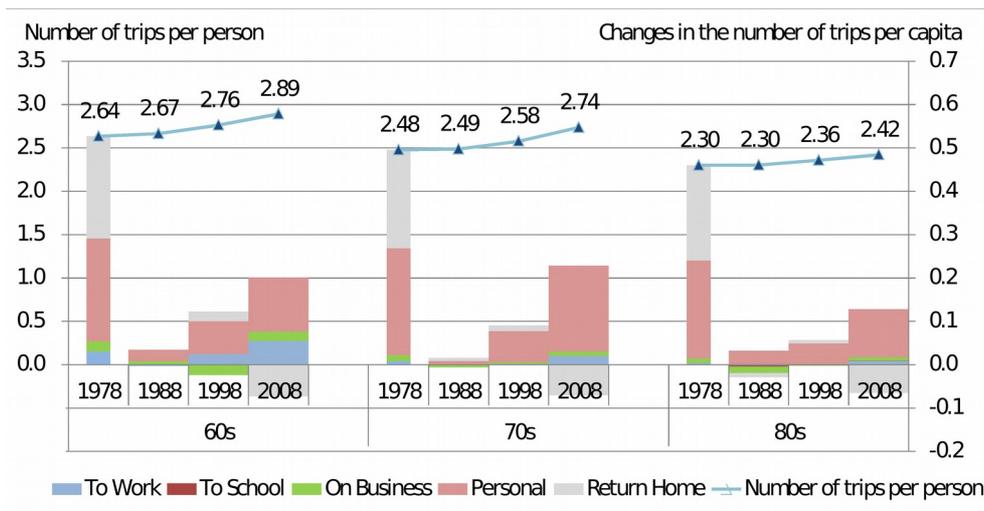


Figure 18. Changes in number of trips per person of senior females by trip purpose

5.2 Analysis of Travel Behavior of a Generation Through Time Series Tracking

a) Changes in going-out rate and net generation intensity

Male rates of leaving home are nearly constant at about 90% for all generations until 50 years old. This rate decreases after 60 years old, but it gradually increases compared with other generations (Figure 19) relative to the extension of the retirement age and the improvements of health in the elderly.

The female rate of leaving home was mostly flat, at about 80%, through the fifth decade, and then it decreases the ages 60–69 onward. The numbers of healthy elderly women are participating in society, and the female rate of leaving home has been gradually increasing within each generation, as with the male rate (Figures 19).

No significant change has been seen in the male number of trips per person, which remained flat at about 3.0 trips per person per day. The peaks, for those born in the 1930s at 40–49 years old, for those born in the 1940s at 30–39 years old, and for those born in the 1950s at 20–29 years old, all of which are high economic growth period in 1978. It is evident that the activities of young people (baby boomers) during that period were extensive (Figure 20).

On the other hand, females experienced their peaks from 30 to 39 years old, regardless of their generation, and it decreased as they aged. Among these, Number of trips per person is high for those born in the 40s, 50s, and 60s. The period from 30 to 39 years old is generally the most hectic for any generation, which is around the time when they are married, give birth, parenting, work at company (Figure 20).

b) Changes in Number of trips per person by trip purpose

We analyzed the changes in travel behavior by life stage via a trip purpose number of trips per person to investigate how this differs in each generation.

The male number of work trips per person is high throughout the ages 50 to 59 years, and it decreases after they enter their 60s after retiring. This change in the characteristics of travel behavior according to life stage is the same, regardless of the generation.

However, the number of work trips per person for those from 30 to 59 years old has been increasing for the generations that were born in the 1910s before the war, up until those born in the 1940s (baby boom- er generation). These generational periods give a glimpse into the social changes and shifts from agriculture

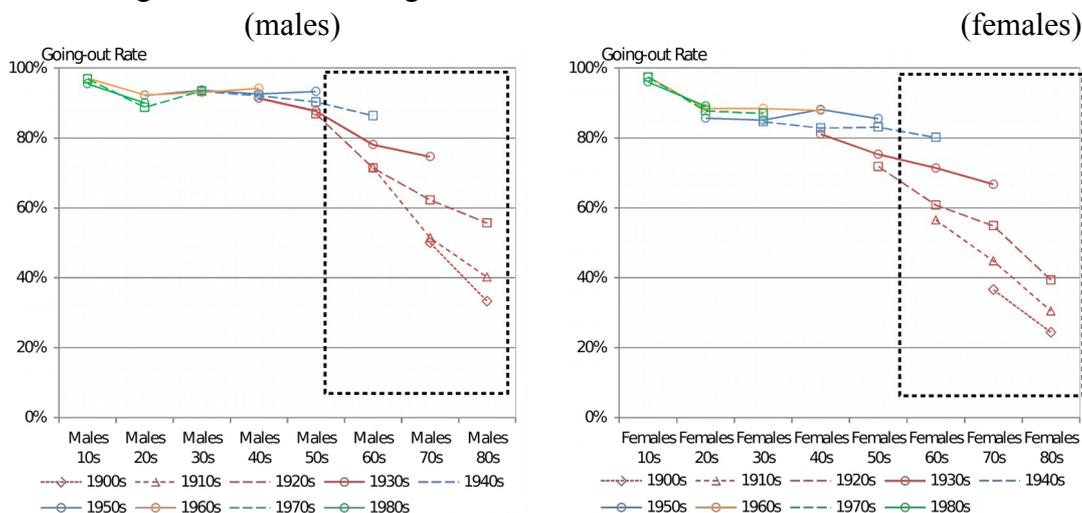


Figure 19. Transitions in going-out rate by generation

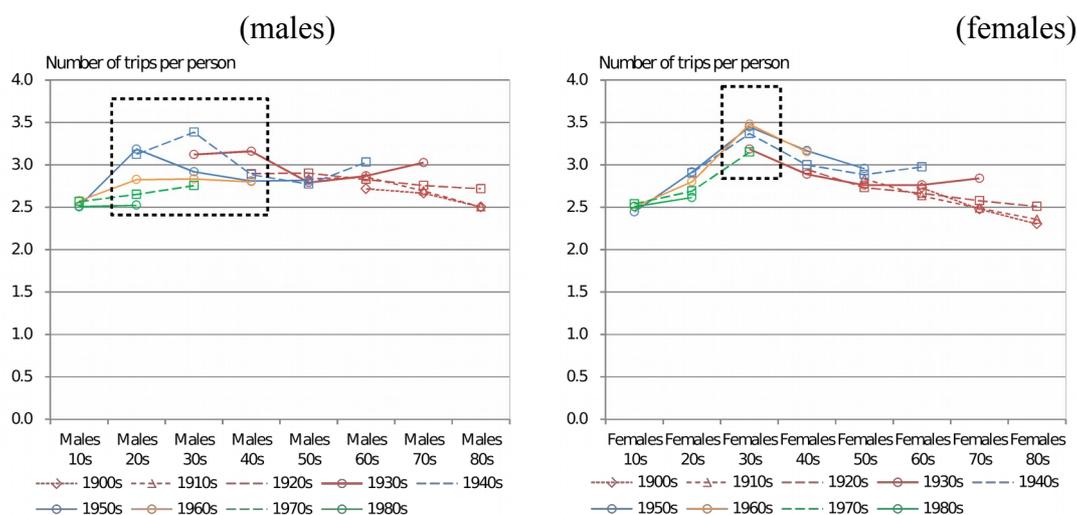


Figure 20. Transition in Number of trips per person by generation

and family businesses to the salaryman system. Number of trips per person of the teens born in the 60s, 70s, and 80s were smaller than the ones of those born in the 50s, which gives a glimpse of social shifts into the era when everyone enters university (Figure 21).

Female number of work trips per person decrease in their 20s and 30s, increase in their 40s and 50s, and decrease once again after retirement in the 60s, giving illustrates an M-shape trend. This indicates women's tendency to take an early retirement and leaves of absence due to marriage, childbirth, and other events, generally completely returning to work in their 40s and 50s. Although 30 to 39 years old born in the 1930s are found at bottom of the M curve, the rate of reduction of Number of trips per person between the ages of 20 to 39 years shrinks in proportion to how young the generation is, which may be due to the

progression of the tendency to enter marriage later, have childbirth later, and live in a dual-income household (Figure 21).

The male number of business trips per person from ages 20 to 49 shrinks in proportion to how young the generation is. As noted above, we consider that this is due to changes in working style resulting from the advancement of communication technology, which reduced the requirements to meet face to face, especially for the younger generations. On the other hand, the rate of reduction is smaller for those who are 50 years old or older than for those in from 20 to 49 years old. The impact on the work of those who are 50 years old

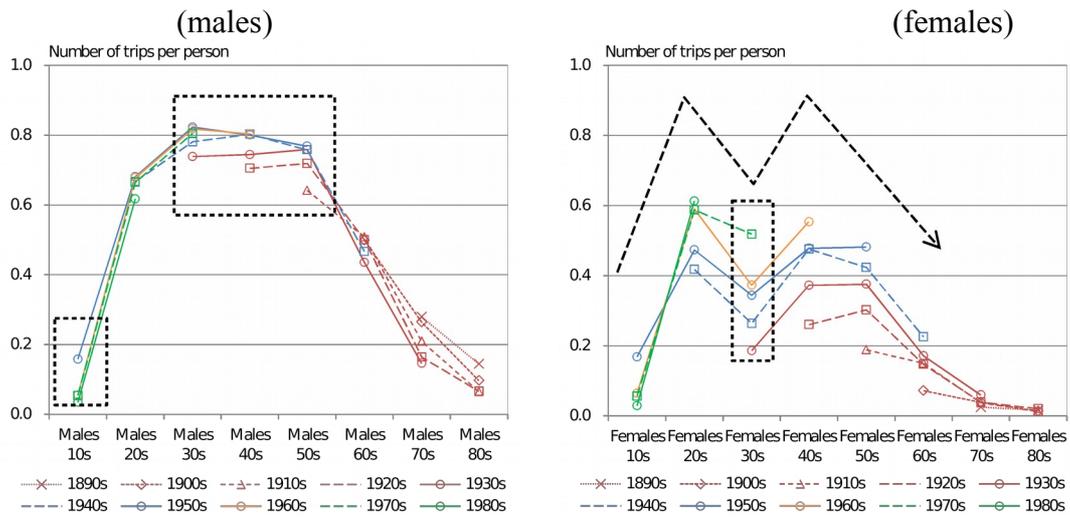


Figure 21. Number of work trips per person by generation

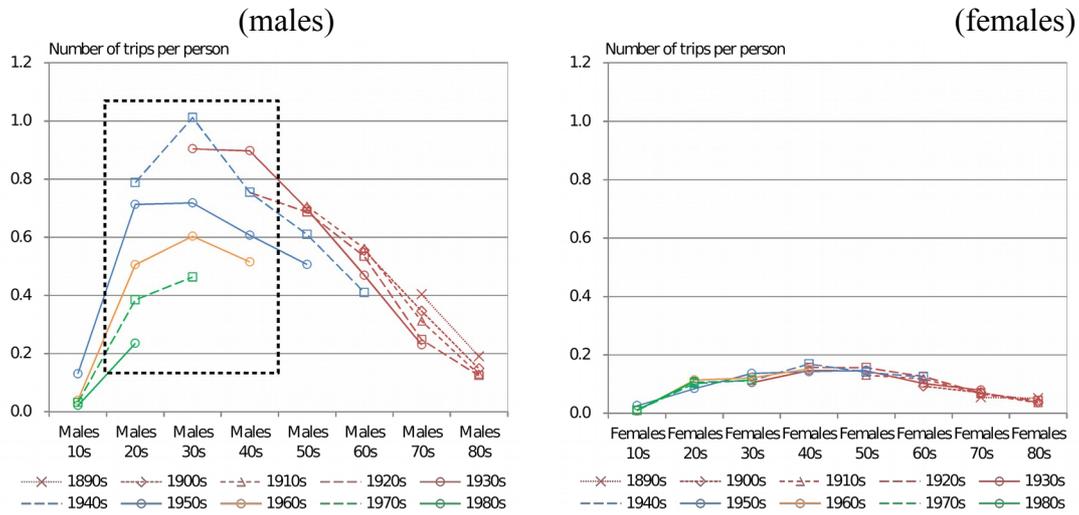


Figure 22. Number of business trips per person by generation

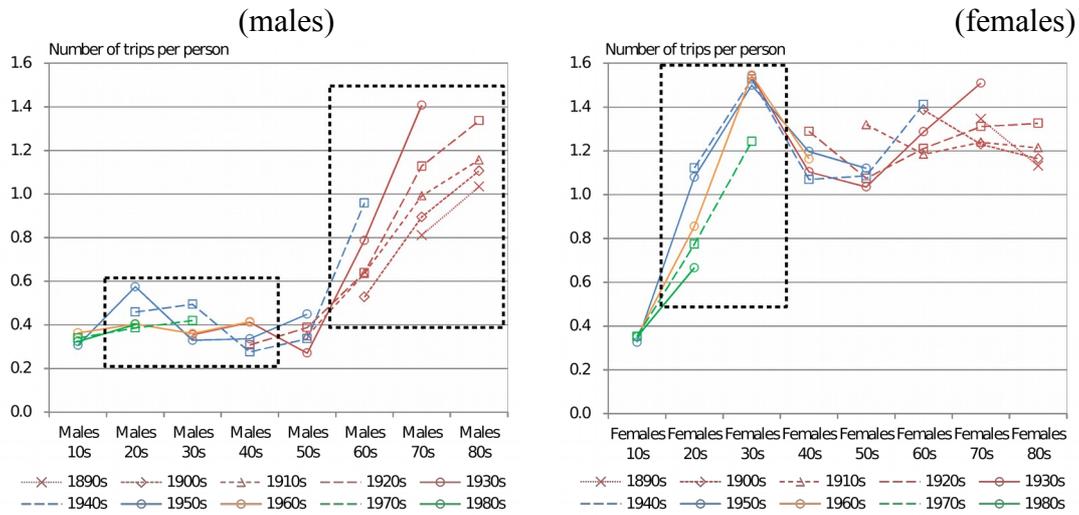


Figure 23. Number of personal trips per person by generation

or older of advances in communication technology has been minimal, and no generational difference was found (Figure 22).

No significant differences were seen in female number of business trips per person. This may be due to the conflicting phenomena of reduction in business trips due to the advancement of communication technology and a compensating increase in trips due to the growth of the female workforce (Figure 22).

Male number of trips per person exhibit low numbers of personal trips until and throughout their 50s, with increases after they enter their 60s, and this was found to be true for all generations. After the units enter their 60s, increases in personal trips appear in proportion to how young the generation is, which allows a glimpse of social changes in the increases in the activity of the elderly due to increases in the number of healthy elderly adults. The peaks of personal trips for those born in the 1930s, 1940s, and 1950s occurred during their 40s, 30s, and 20s, respectively, which all coincide around 1978 (53PT). In 1978, all these generations were active, not only in commuting and working but in their personal affairs as well (Figure 23).

The personal trips of the female number of trips per person increased in number until their 30s, decreases in their 40s and 50s, and increases once again in their 60s. This trend was the same for all generations. In 20s, the number of personal trips per person is decreasing as the generation becomes younger. Various factors are involved, including reductions in free time due to dual-income households, parenting, and other responsibilities (Figure 23).

6. SUMMARY

This paper takes the following findings from the analysis of the changes in the characteristics of travel behavior focused on life stages relative to period and generations, using data from the PT surveys of the TMA taken five times, every ten years.

Regarding changes in travel behaviors due to changes in social systems and technologies, the following has been made clear.

(1) Advances in communication technology and travel behaviors change

Advances in communication technology have changed work styles and decreased the number of business trips.

In the examination of the changes in travel behaviors from 1968 to 2008, the decrease in the activity of the younger generational units was due to changes in the working style as a result of advancement in communication technology more so than changes in values, as has been proposed by other researchers.

Men in their 50s have more face-to-face work meetings than young people do, and there is little influence on the number of business trips from the advancement of communication technology.

During the period we analyzed (1968-2008), the Japanese economy stagnated temporarily due to the collapse of the bubble economy in 1991, but GDP has grown at an annual average of 1.5% between 1988 and 2008. It is hard to judge that the economy is continuously affecting the decline in business trips. Regarding the relationship between economic activity and business trip reduction, we want to set it as a future research topic.

(2) Increase in number of dual-income households and travel behaviors change

The female number of work trips per person exhibits an M curve, wherein those in their 30s generally appear at the bottom of the curve, but the reduction rate of this group in the transition period from 20s to 30s it itself being reduced as the generations in this time of life become younger. This reflects social changes due to increases in later marriage, later childbirth, and dual-income households.

The younger the generation is for those in their 20s and for those in their 30s born after 1970, the less personal trips are being taken. This is owing to various factors are involved, including reductions in free time due to dual-income households, parenting, and other considerations.

The increase in dual-income households has increased the number of men who are participating in household chores, performing shopping and child rearing (which relates to transportation).

(3) Increase in university entrance rate and travel behaviors change

The youngest generations exhibit low number of work trips per person in their teens, which reflects an era when everyone enters university.

(4) Change in industrial structure and travel behaviors change

Number of work trips per person have been increasing in generations who were born in the 1910s until those born in the 1940s (baby boomer generation), which shows exhibits the social change and shifts over to the system of salary men working at corporations.

Change in travel behaviors characteristic with regard to generation were not clearly extracted, but it is confirmed that the travel behavior of the baby-boomer generation is more active compared to other generations, and that the travel behavior of the elderly is increasing generation by generation.

(1) Baby-boomer generation's travel behavior

It is evident that those (e.g., baby boomers) who were young during the period of high economic growth had heightened activity.

(2) Activation of travel behavior of the elderly

Due to advancements in medical technology, numbers of healthy elderly people have increased, and they are more active than in the past.

This paper analyzes data from the PT surveys of the TMA to illustrate qualitative changes in society with the use of data. This is possible thanks to the data that has been accumulated by the PT surveys over five decades. Because the data cover up to 2008, more recent phenomena are not covered, such as the increase in youth who choose not to leave their homes due to social withdrawal.

Because the present study does not categorize data relative to factors that can impact travel behavior, such as work situation and family structure, only analyzing rates of leaving

home and number of trips per person by age group, it may not have thoroughly accounted for certain phenomena.

In our next study, we intend to categorize data relative to work situation, family structure, and other factors, limiting the analysis to specific age groups, such as younger generations, women, or the elderly to promote a more detailed analysis. By doing so, we could like to help predict the future medium-to-long term travel behaviors corresponding to changes in the socioeconomic situation including aging society in future and consider measures for it.

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