GTA TRIP GENERATION RATES, 1986 - 1996

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1. INTRODUCTION

The home-to-work (HW) trip generation model used in both the Simplified GTA Model and the Full GTA Model is given by:

$$HW_i = POP_i * LFPR_i * (1-WAH_i) * RATE24_i * PPF_i \quad [1]$$

where:

HW_i	=	morning peak-period work trips from origin zone i
POP_i	=	population in zone i
$LFPR_i$	=	average labour force participation rate in zone i (full- plus part-time)
WAH_i	=	fraction of workers who work at home in zone i
$RATE24_i$	=	average number of 24-hour home-to-work trips per worker not working at home in zone i
PPF_i	=	fraction of work trips occurring during the morning peak-period in zone i (trip start time 6:00-8:59, inclusive)

In practice, the rates used are average values for the Planning District within which zone i is located.[1]

This report investigates the changes which have occurred in GTA work trip rates over the period 1986-96, as well as some of the underlying factors affecting these changes. All data are drawn from the 1986, 1991 and 1996 TTS datasets. The analysis proceeds in two parts. Section 2 documents overall or "macro" trends in trip rates, at both the GTA level and by regional municipality, while Section 3 provides a more detailed investigation of variations in LFPR, WAH, RATE24 and PPF by age, gender and employment status (full-time versus part-time). The primary objective of both analyses is to achieve a better understanding of the factors which may fundamentally affect population-based trip generation rates over time and space. Section 4 then concludes the report with a brief discussion of possible future trends and their implications for trip generation forecasting.

[1] Or, in some cases outside Toronto, sub-divisions of Planning Districts.

2. CHANGES IN GTA TRIP GENERATION RATES, 1986-96

This section examines significant trends in trip rates for the entire GTA region as well as on the scale of the regional municipalities. In each of Figures 1 through 7, percentage changes for the time periods 1986-91 and 1991-96 are plotted for each of the following variables:

1. population;
2. labour force participation rate;
3. work at home (Change in proportion of labour force that works outside the home);
4. daily first work trips per person employed outside the home;
5. morning work trip peak-period factor (fraction of daily work trips occurring during the morning peak period);
6. non work trip adjustment factor applied to work trips;
7. total morning peak period trip origins; and
8. morning peak period work trip destinations (i.e., at the place of work).

2.1 Overall GTA Trends

As shown in Figures 1a and 1b, total population in the GTA increased by 21% over the period 1986-96. At the same time the labour force participation rate (LFPR) for people living in the GTA declined by 11%. This decline in LFPR most likely is largely due to structural changes in the economy during this time period, but may also reflect shifts in the age distribution of the population in which there is a growing number of children and retired people and relatively fewer people of working age.

Figure 1a and b - Changes in Socio-Demographic and Travel Characteristics in the GTA

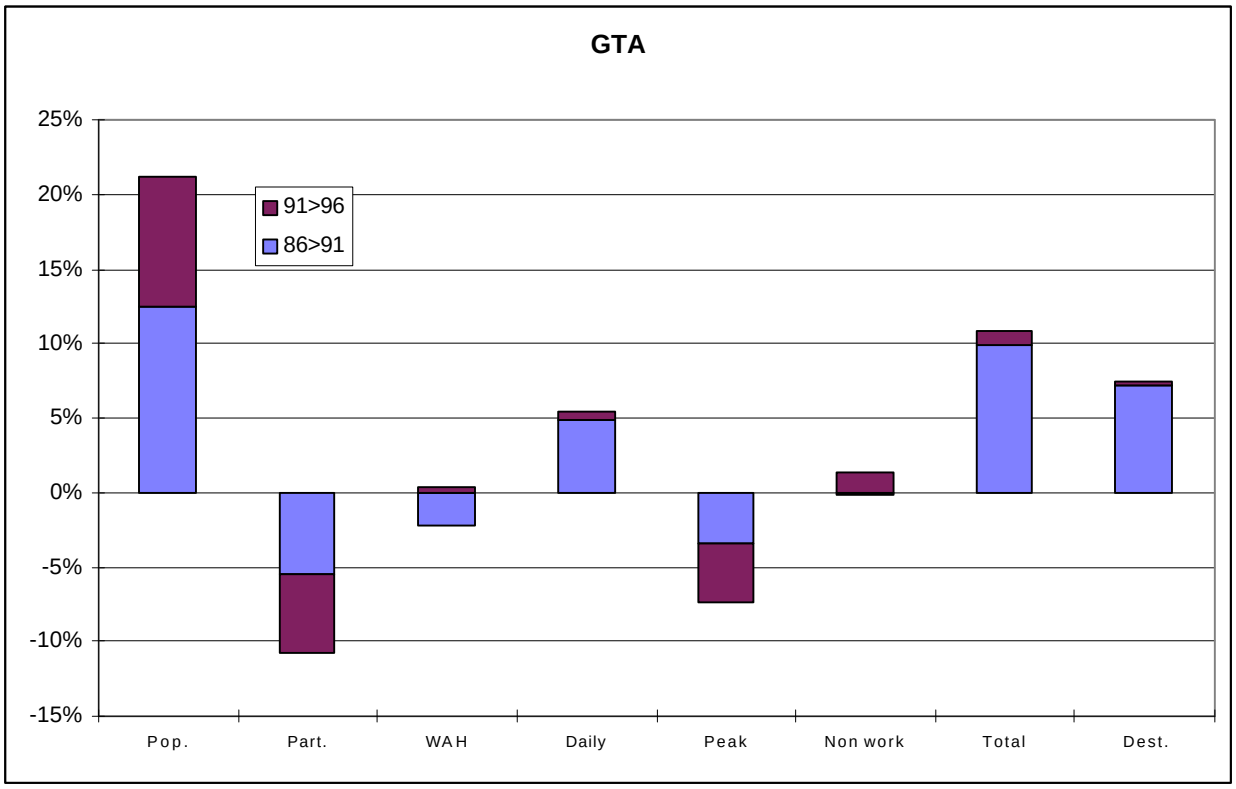
Figure 1a

GTA	86>91	91>96	86>96
Pop.	12%	9%	21%
Part.	-5%	-5%	-11%
WAH	-2%	0%	-2%
Daily	5%	1%	5%
Peak	-3%	-4%	-7%
Non work	0%	1%	1%
Total	10%	1%	11%
Dest.	7%	0%	8%

Pop.	Population
Part.	Participation in employed labour force
WAH	Change due to Work at Home
Daily	Daily First work trips per person employed outside the home
Peak	a.m. peak period factor
Non work	Non work factor (a.m. peak)
Total	Product of above factors
Dest.	a.m. peak work trip destinations

91>96 growth is expressed as % of 86

Figure 1b



The daily first trip to work trip rate for the entire GTA area increased by 5% over the period 1986-91 and again slightly increased from 1991 to 1996. As opposed to this increase, the work trip rate for the morning peak period declined by a total of 7% over the 1986-96 period. This suggests the influence of a change in temporal travel habits by trip makers. There was also a slight increase in the non-work rate over the time period, as well as an 8% increase in morning peak-period work trip destinations across the GTA.

2.2 Trends by Regional Municipality

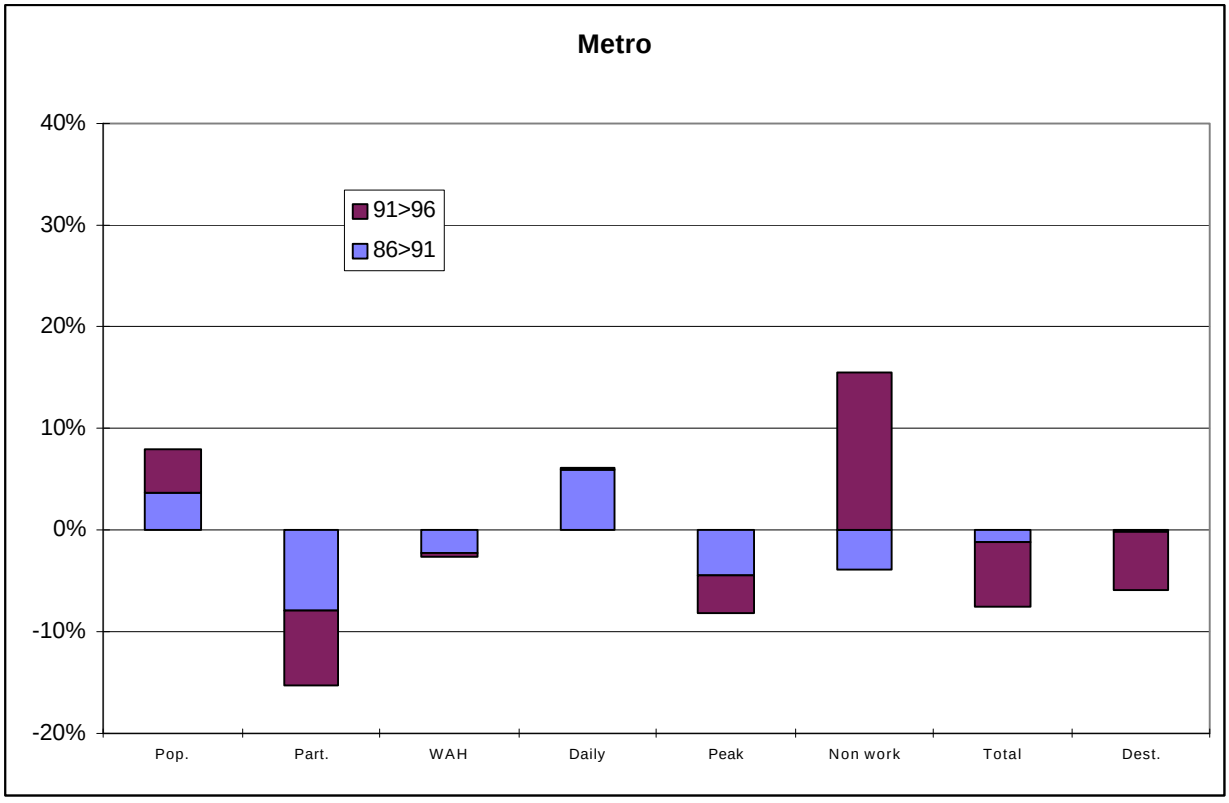
For the City of Toronto (formerly the Municipality of Metropolitan Toronto), as shown in Figures 2a and 2b, the daily first trip to work increased by 6% from 1986 to 1991 but did not increase from 1991 to 1996. The peak period work trip rate exhibited trends similar to that of the entire GTA, and steadily decreased over the time frame with an overall decrease of 8% occurring over the time period of 1986 to 1996.

Figure 2a and b - Changes in Socio-Demographic and Travel Characteristics for the City of Toronto (formerly the Municipality of Metropolitan Toronto)

Figure 2a

Metro	86>91	91>96	86>96
Pop.	4%	4%	8%
Part.	-8%	-7%	-15%
WAH	-2%	0%	-3%
Daily	6%	0%	6%
Peak	-5%	-4%	-8%
Non work	-4%	15%	12%
Total	-1%	-6%	-7%
Dest.	0%	-6%	-6%

Figure 2b



There was a significant increase in the proportion of non-work a.m. peak-period trips with an overall increase of 12% in the non work adjustment factor occurring in the period 1986 to 1996 after an initial 4% decrease between 1986 and 1991. The increased proportion of non work trips reflects a decline in work trip rates more than an increase in non work trip rates. Another interesting observation is that the work trip destinations across Toronto decrease by 6% from the 1986 numbers suggesting that work trip destinations are becoming more decentralized from Toronto than they once were.

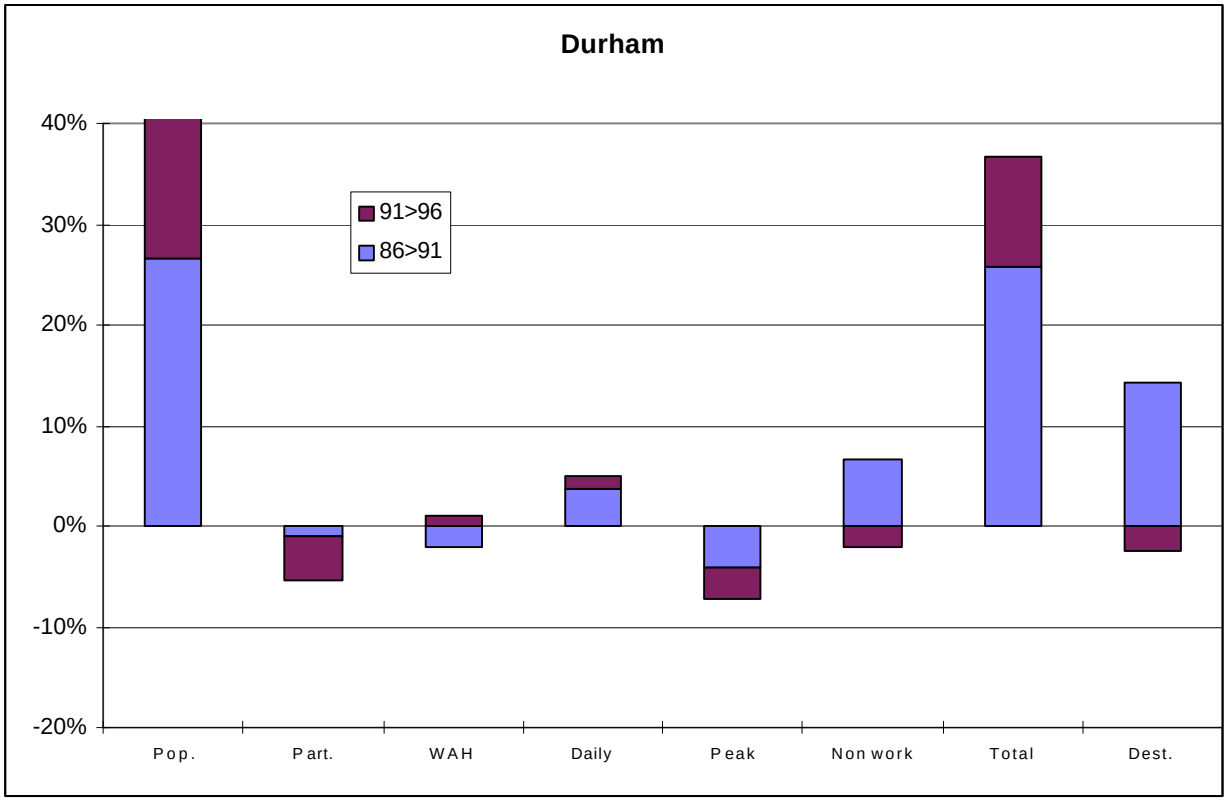
Durham Region (Figures 3a and 3b) shows a 5% increase in daily first trip to work and a 7% decrease in peak-period work trips since 1986. The proportion of non-work trips increased slightly by 4% from 1986 to 1996 and there was a significant increase in work trip destinations of 12% over the time frame 1986-96. This increase probably reflects increased work opportunities in the region.

Figure 3a and b - Changes in Socio-Demographic and Travel Characteristics for Regional Municipality of Durham

Figure 3a

Durham	86>91	91>96	86>96
Pop.	27%	15%	42%
Part.	-1%	-4%	-5%
WAH	-2%	1%	-1%
Daily	4%	1%	5%
Peak	-4%	-3%	-7%
Non work	7%	-2%	4%
Total	26%	11%	37%
Dest.	14%	-3%	12%

Figure 3b



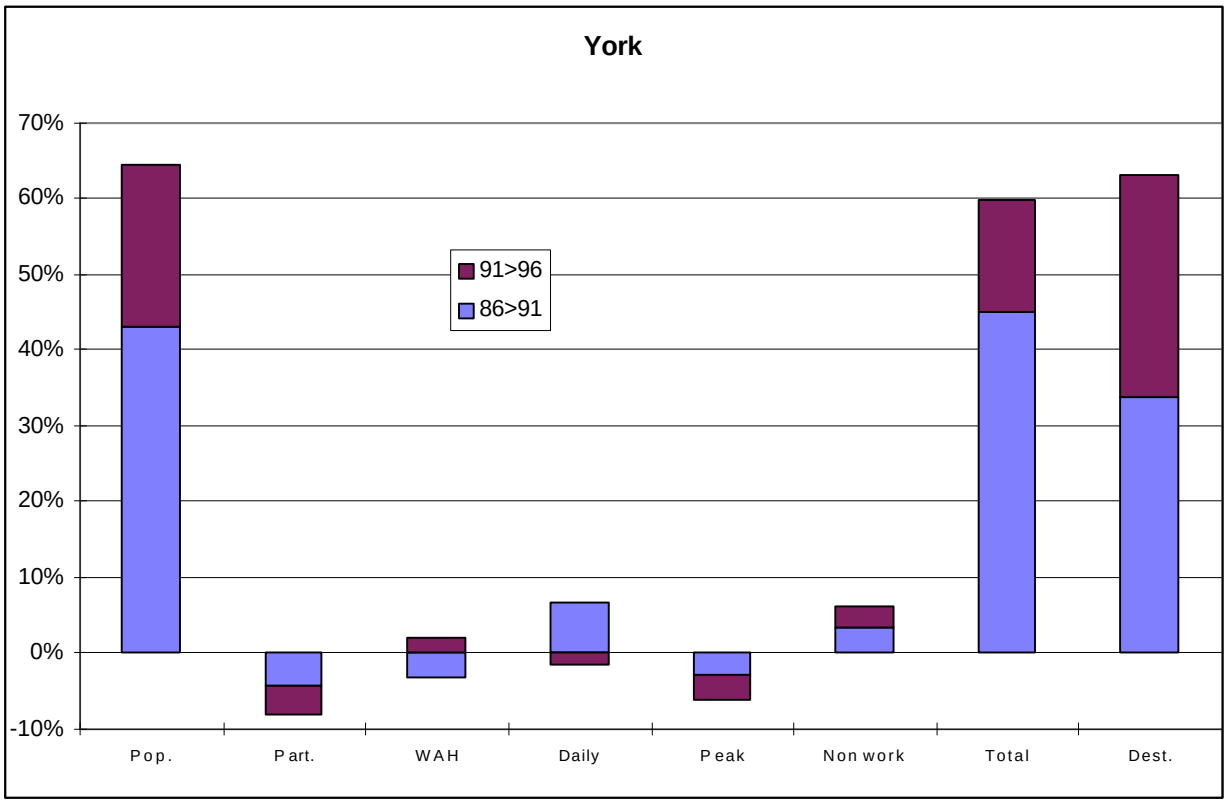
Figures 4a and 4b both show data for York Region. Daily Work Trips increased by 7% over the period 1986-91, and then slightly decreased from there until 1996 to give an overall increase of 5% for 1986-96. Peak period work trips declined evenly from 86-96 for a 6% decrease while the proportion of non-work Trips in the morning peak period increased by 6%. The most significant increase was seen in the work trip destinations with increases of 34% between 86-91 and 29% between 91-96 suggesting that the region is rapidly developing and producing a substantial increase in employment opportunities in York Region in the past 10 years.

Figure 4a and b - Changes in Socio-Demographic and Travel Characteristics for the Regional Municipality of York

Figure 4a

York	86>91	91>96	86>96
Pop.	43%	22%	65%
Part.	-4%	-4%	-8%
WAH	-3%	2%	-1%
Daily	7%	-2%	5%
Peak	-3%	-3%	-6%
Non work	3%	3%	6%
Total	45%	15%	60%
Dest.	34%	29%	63%

Figure 4b



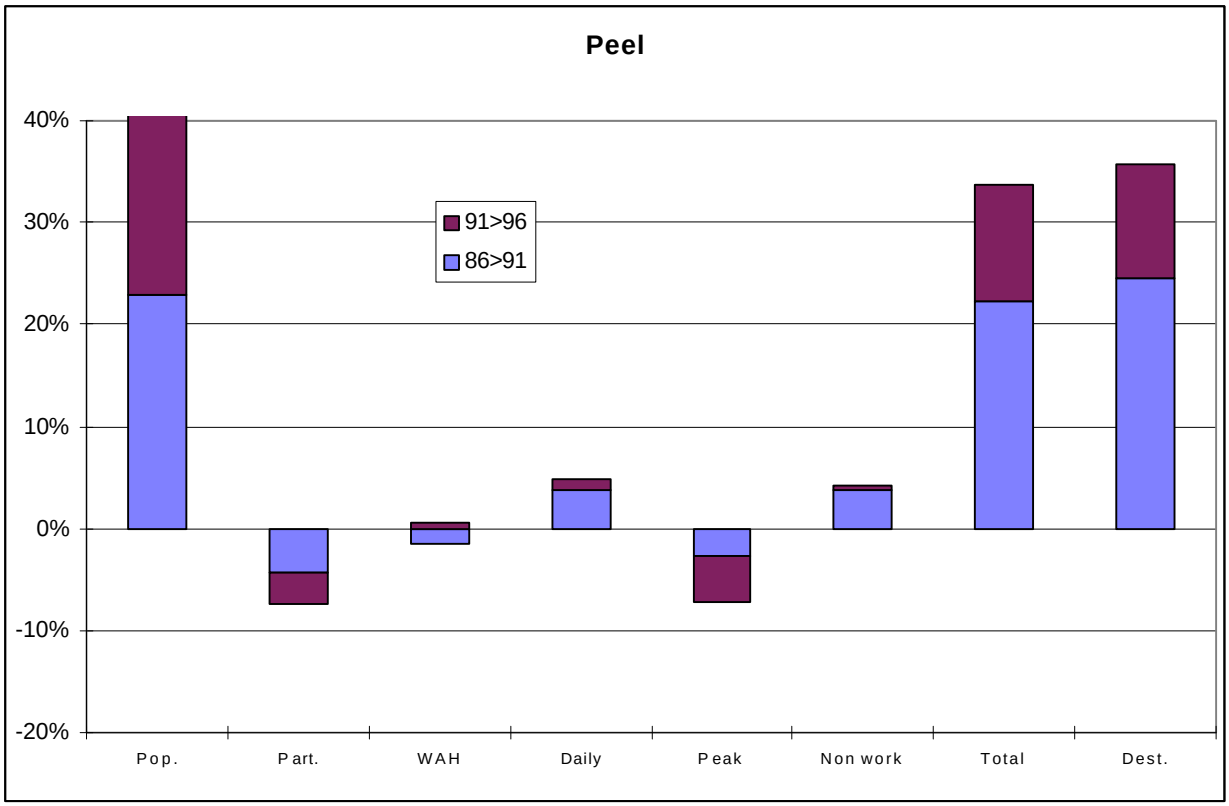
Peel Region (Figures 5a and 5b) shows a similar increase in daily work trips, decrease in peak period work trips, and increase in non-work peak period trips to the other regions. Work trip destinations increased significantly by 36% over the entire period. Most of this growth occurred in the 86-91 period when they increased by 25%.

Figure 5a and b - Changes in Socio-Demographic and Travel Characteristics for the Regional Municipality of Peel

Figure 5a

Peel	86>91	91>96	86>96
Pop.	23%	18%	41%
Part.	-4%	-3%	-7%
WAH	-1%	0%	-1%
Daily	4%	1%	5%
Peak	-3%	-5%	-7%
Non work	4%	1%	4%
Total	22%	11%	34%
Dest.	25%	11%	36%

Figure 5b



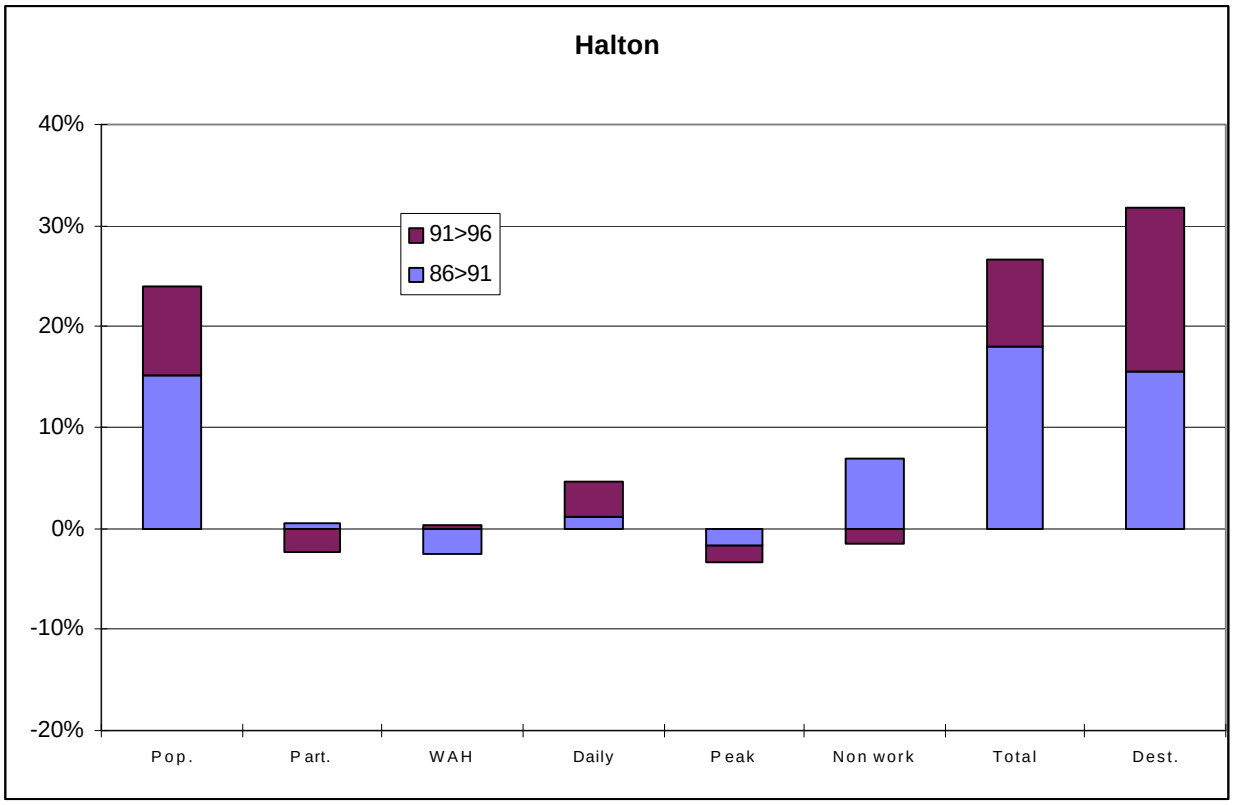
Halton Region (Figures 6a and 6b) follows most of the trends associated with trip rates in the other regions except Metropolitan Toronto. There is also a significant increase in work trip destinations with a 16% increase between 1986 and 1991 and a further 16% increase from 1991-1996.

Figure 6a and b - Changes in Socio-Demographic and Travel Characteristics for the Regional Municipality of Halton

Figure 6a

Halton	86>91	91>96	86>96
Pop.	15%	9%	24%
Part.	0%	-2%	-2%
WAH	-3%	0%	-2%
Daily	1%	4%	5%
Peak	-2%	-2%	-3%
Non work	7%	-1%	6%
Total	18%	9%	27%
Dest.	16%	16%	32%

Figure 6b



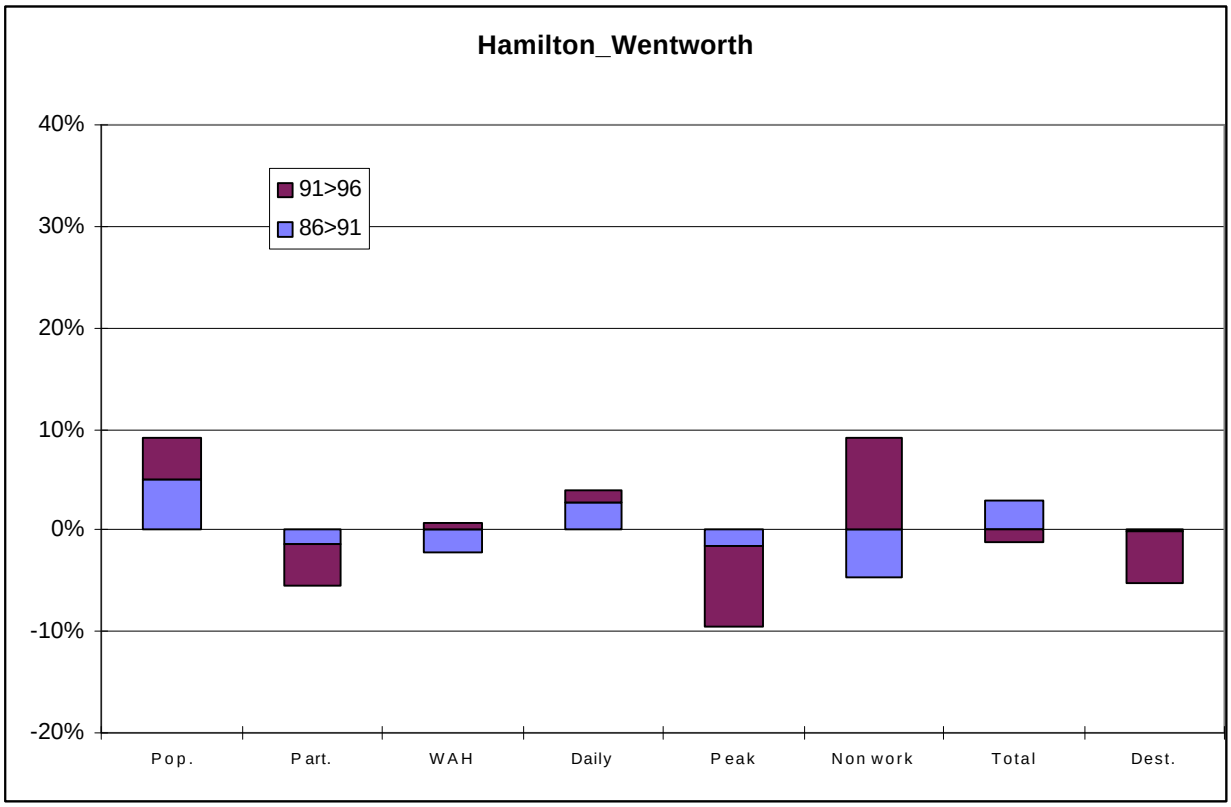
Figures 7a and 7b represent the Hamilton-Wentworth region. The region shows an increase in daily first trips to work. There is also a significant decrease in peak period work trips which has been more pronounced in the 1991 to 1996 period. Work destinations decreased by 5%.

Figure 7a and b - Changes in Socio-Demographic and Travel Characteristics for the Regional Municipality of Hamilton-Wentworth

Figure 7a

Hamilton-Wentworth	86>91	91>96	86>96
Pop.	5%	4%	9%
Part.	-1%	-4%	-5%
WAH	-2%	1%	-2%
Daily	3%	1%	4%
Peak	-2%	-8%	-10%
Non work	-5%	9%	4%
Total	3%	-1%	2%
Dest.	0%	-5%	-5%

Figure 7b



2.3 Summary of Spatial Trends

The following observations/conclusions were made about trip rates from the data presented:

1. Labour force participation rates have declined significantly across the GTA with the magnitude of the decrease ranging from 2% in Halton Region to 15% in Toronto.

2. Daily first work trips per person employed outside the home have generally increased between 4 to 6% for all areas of the GTA.

3. Peak period trips have similarly decreased across the GTA. This may be due to changes in temporal travel habits.

4. There has been a general increase in the proportion of trips occurring in the a.m. peak period which are not work related. The most significant increase occurs in Toronto with a 12% increase in the non work adjustment factor over the 10 year period.

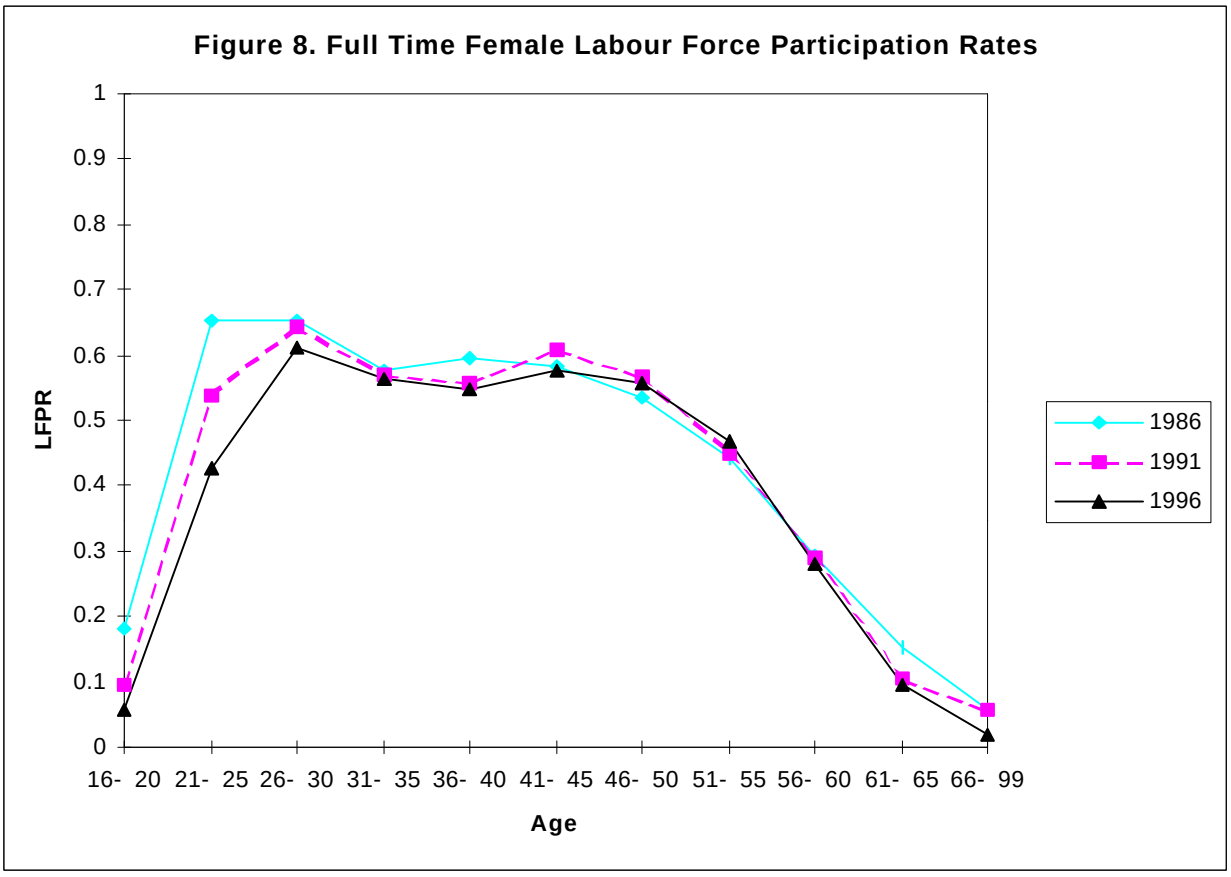
5. Overall, there has been an increase in work trip destinations in the GTA region. However, there has been a decrease in Toronto and Hamilton-Wentworth, the two most built up areas in the study. The other regions have seen significant growth in work trip destinations, reflecting the considerable growth in employment opportunities which has occurred in these regions.

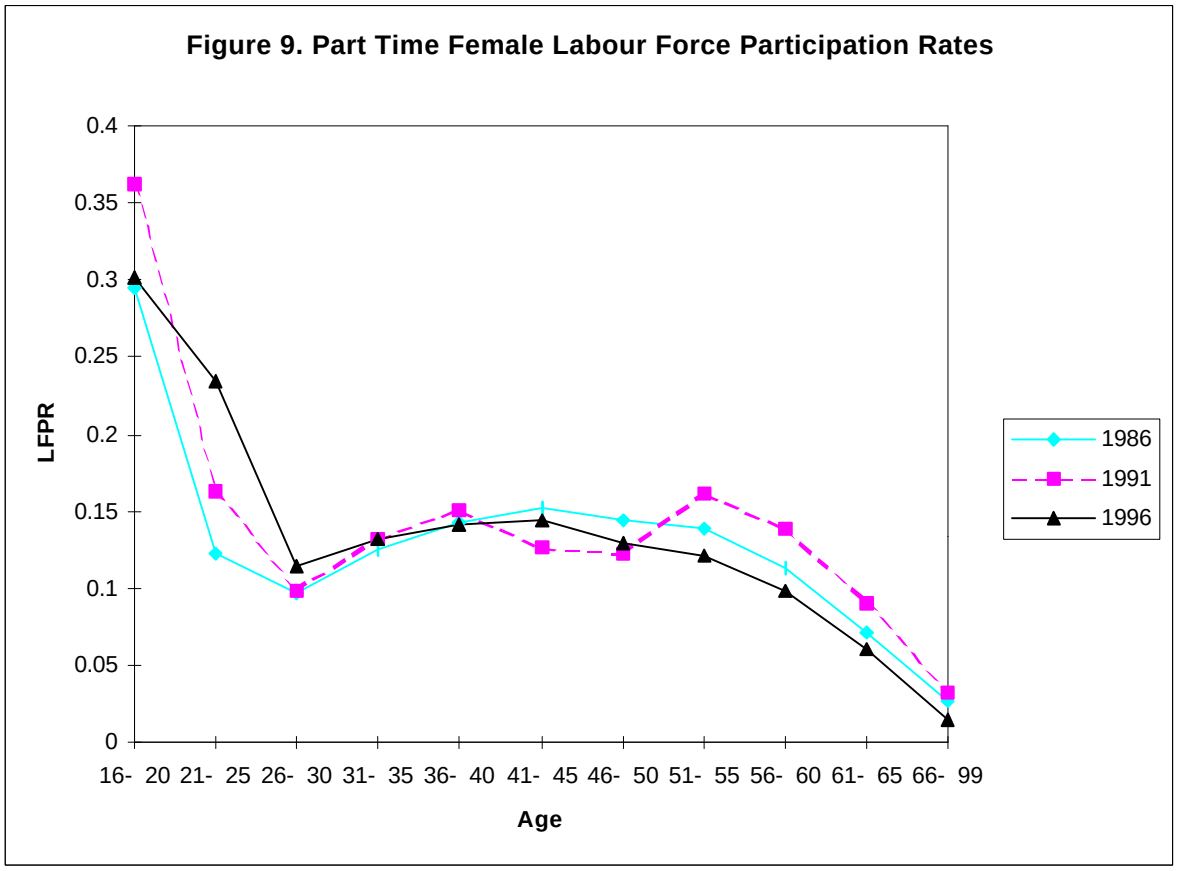
3. DEMOGRAPHIC FACTORS AFFECTING WORK TRIP GENERATION

In this section, the trends in work trip-making discussed in the previous section are further disaggregated by worker age, sex and employment status (full-time versus part-time) in order to achieve some insights into the factors underlying the observed aggregate trends. In order to keep the analysis relatively simple, all data are analyzed at the spatial level of the entire GTA.

3.1 Observed Trends

Figures 8 and 9 plot female LFPR by age category for the three survey years, for full-time and part-time participation, respectively. For women over the age of 30, full-time LFPR rates have been relatively constant, while full-time LFPR has declined significantly for younger women, especially in the 21-25 age group. About half of this decline in full-time LFPR represents a shift to part-time employment, as shown in Figure 9. The part-time LFPR for women over 30 is, again, relatively stable, although there does seem to be a small general decline in part-time LFPR for women over 45.





The trend for male LFPR is quite different. As shown in Figures 10, male LFPR has consistently declined for all age groups, for full-time employment with the biggest absolute and percentage changes occur for the 21-25 and over 56 age groups. Figure 11 shows that the male part-time LFPR has generally increased over the years with some of this increase representing a shift from full-time employment.

Figure 10. Full Time Male Labour Force Participation Rates

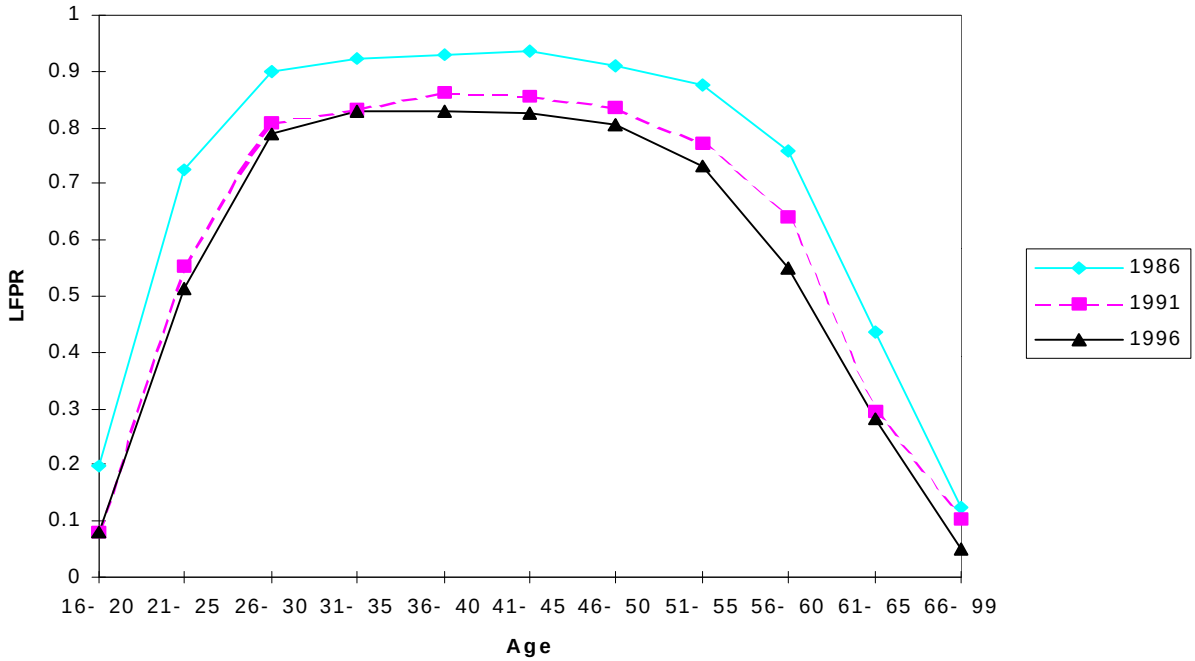
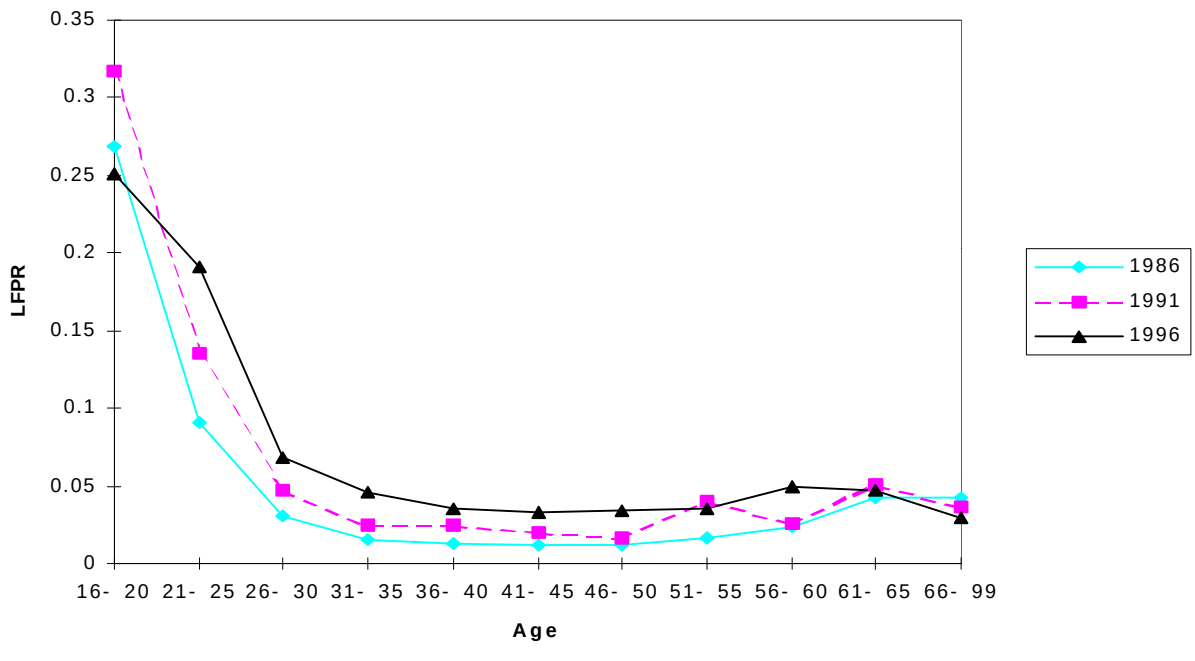
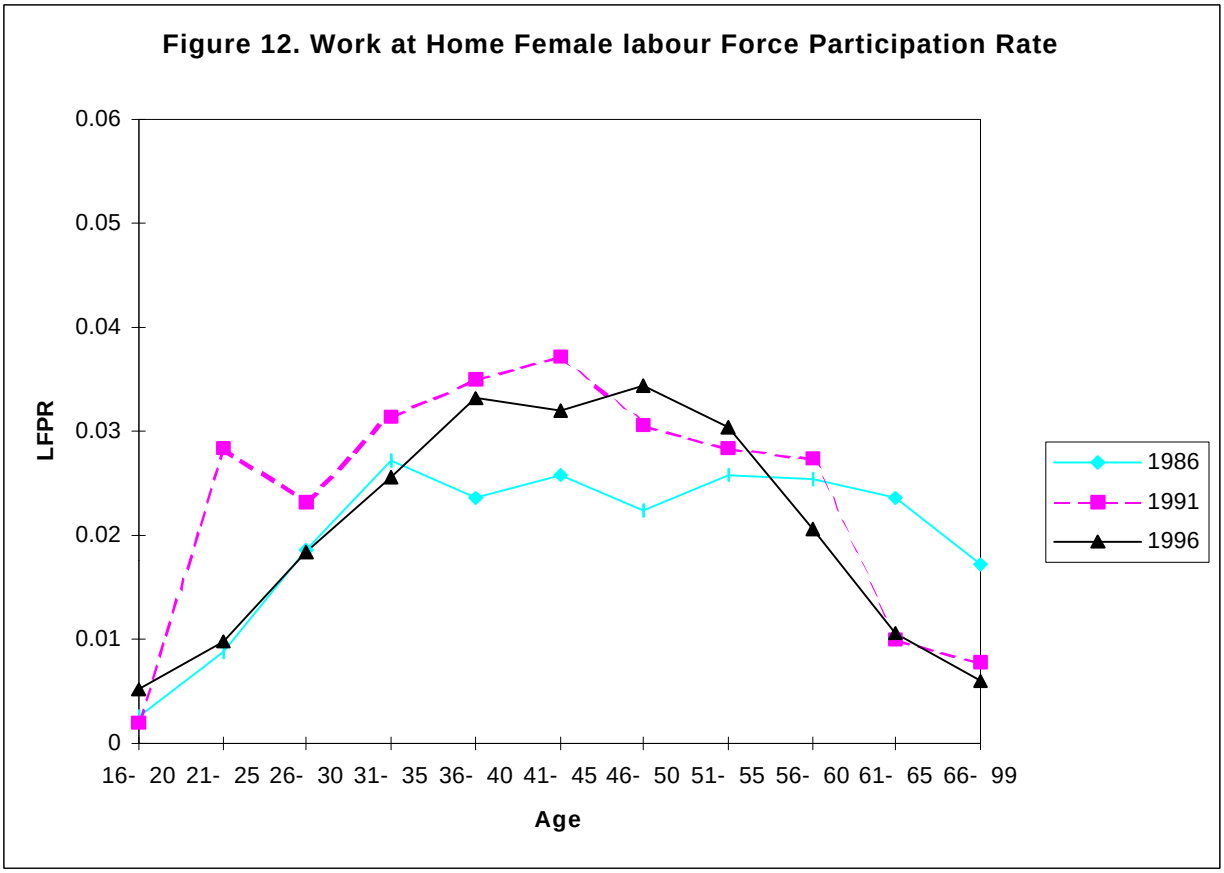
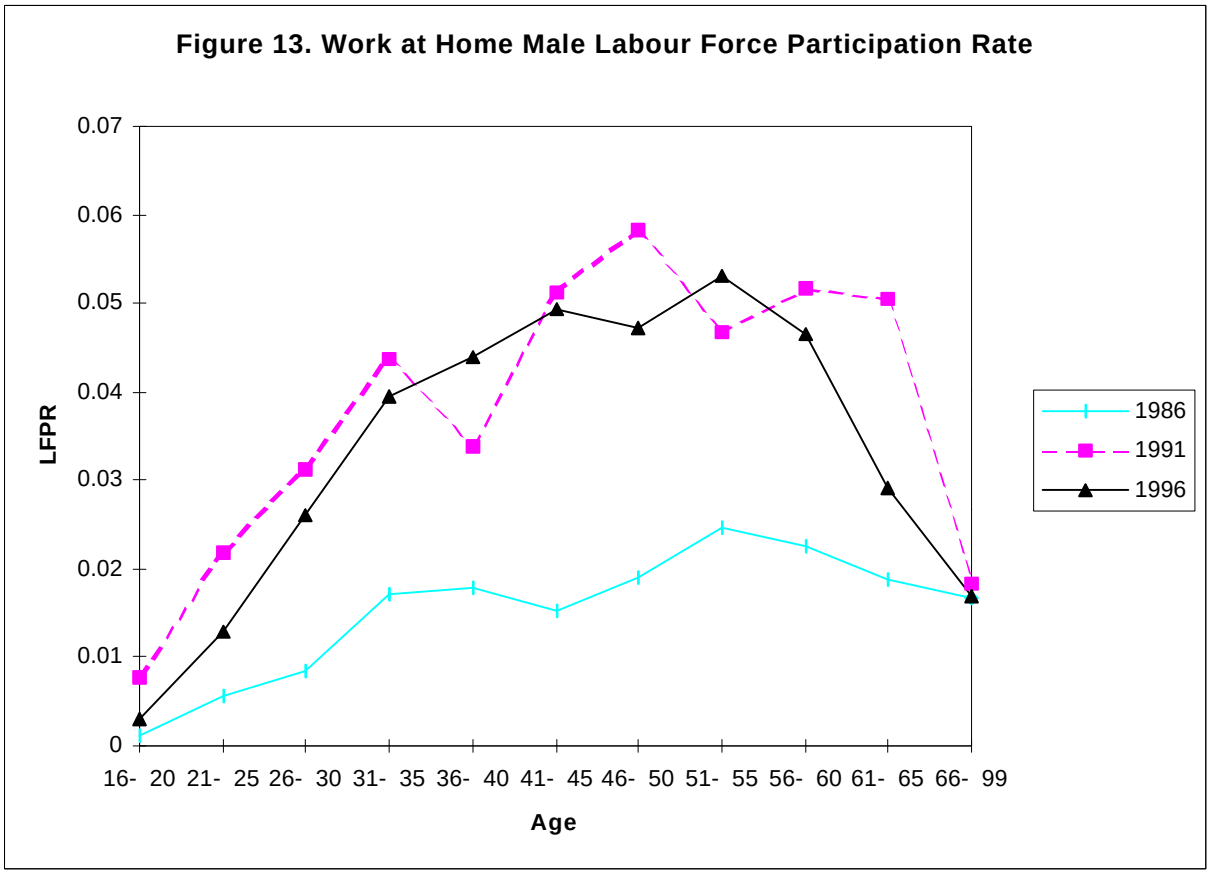


Figure 11. Part Time Male Labour Force Participation Rates



As shown in Figures 12 and 13, work-at-home rates have increased significantly for both women and men, but particularly for men, and for all age groups, but especially for workers above 35 years of age. In most age groups, the male WAH rate has doubled or tripled, to the point that in 1996 generally a higher percentage of male workers work at home than females, reversing the 1986 case. Although there has been a significant percentage increase in the number of people working at home the impact on total work trip generation rates has been small (4% or less in all categories).





Figures 14 and 15 display 24-hour trip rates, by age group, for male and female workers, respectively, for workers employed outside their home, for the three survey years. These trip rates show remarkably little variation over time. They are also very consistent across age groups, with the exception of younger workers, whose lower daily trip rates reflect their much higher likelihood of working part-time.

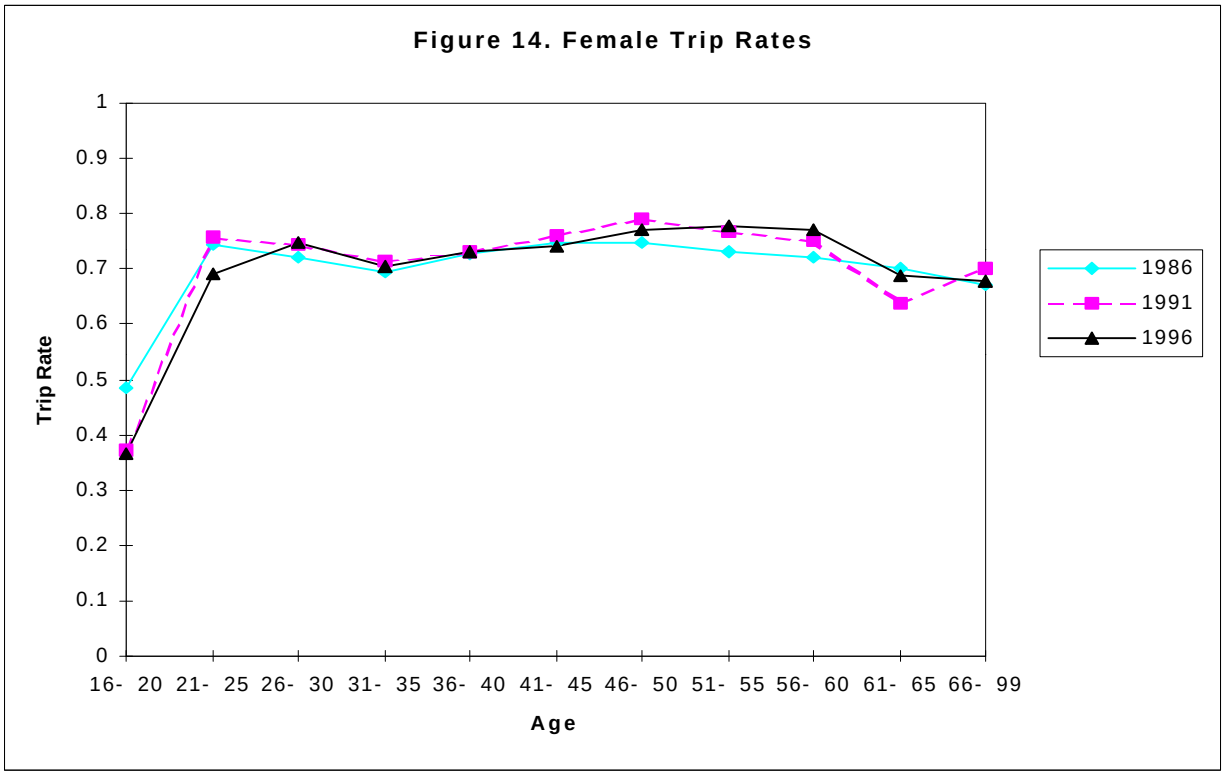


Figure 14. Female Trip Rates
Trip Rate
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
16- 20 21- 25 26- 30 31- 35 36- 40 41- 45 46- 50 51- 55 56- 60 61- 65 66- 99
Age
1986
1991
1996

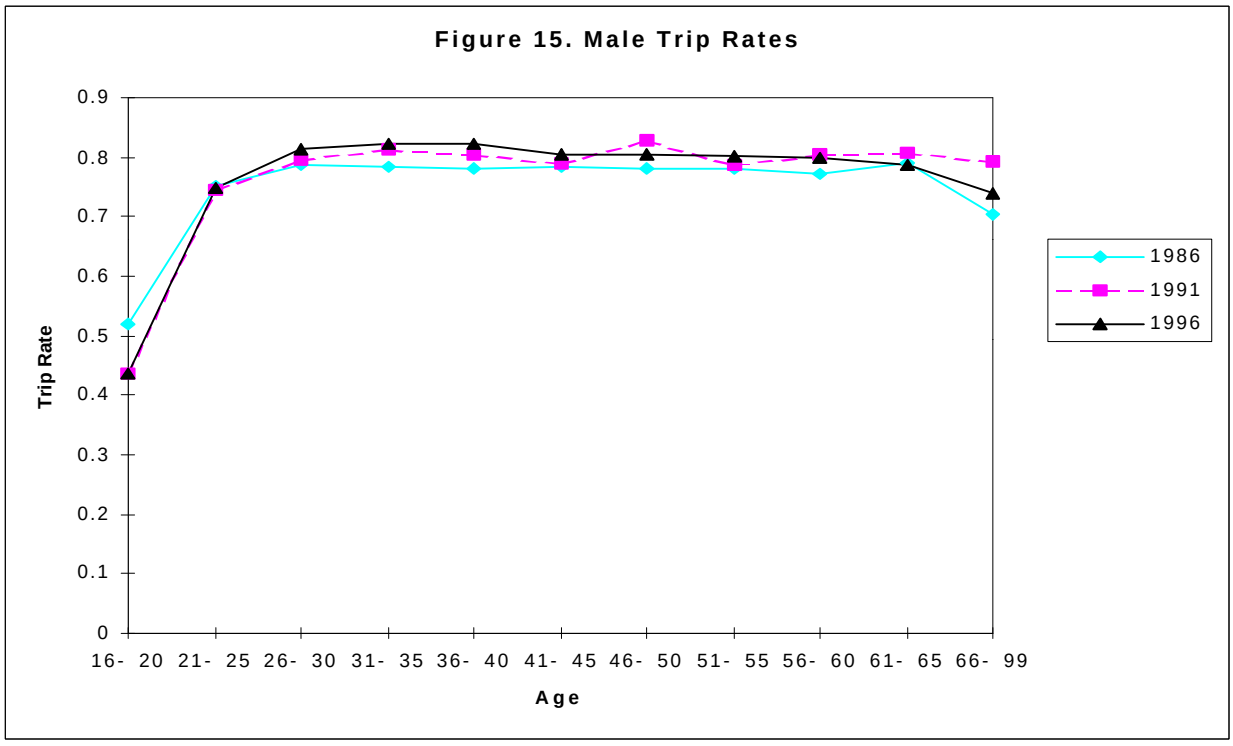
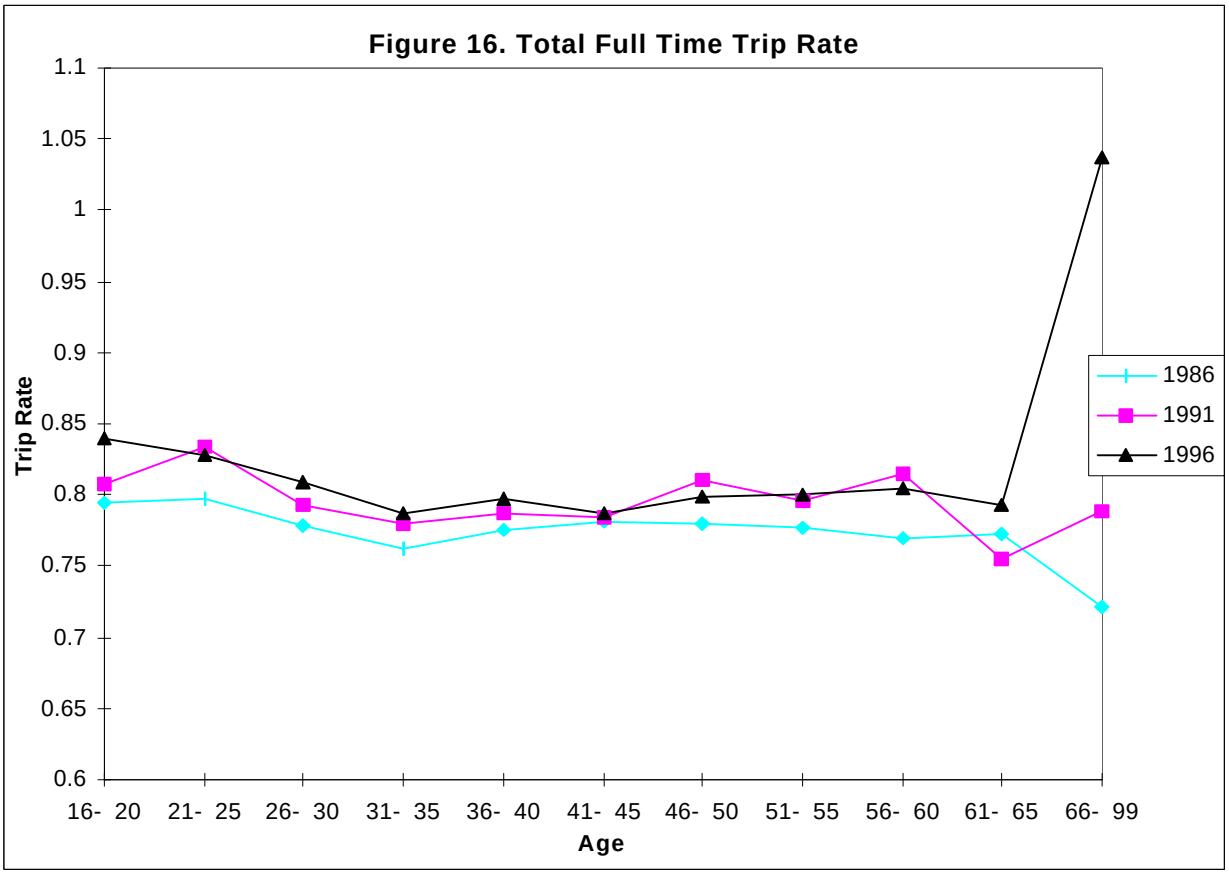
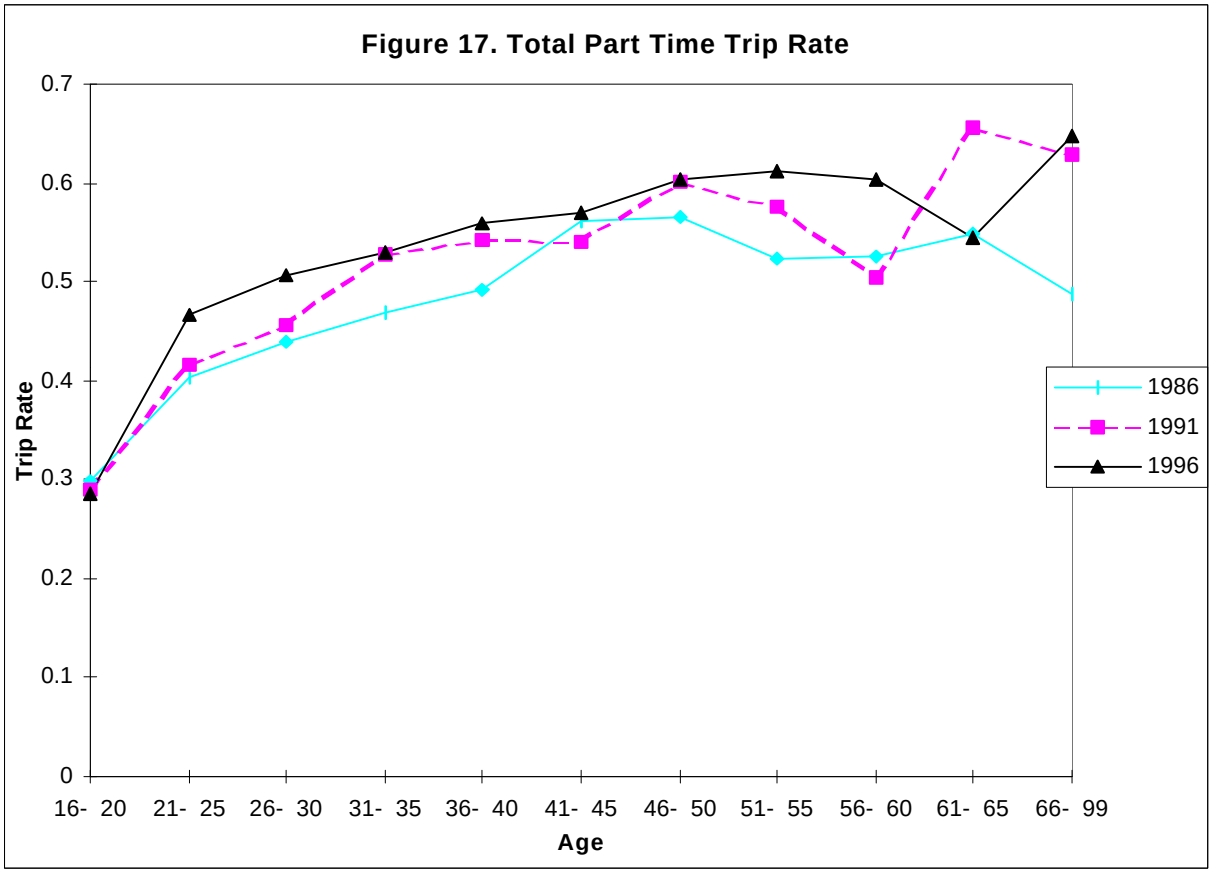


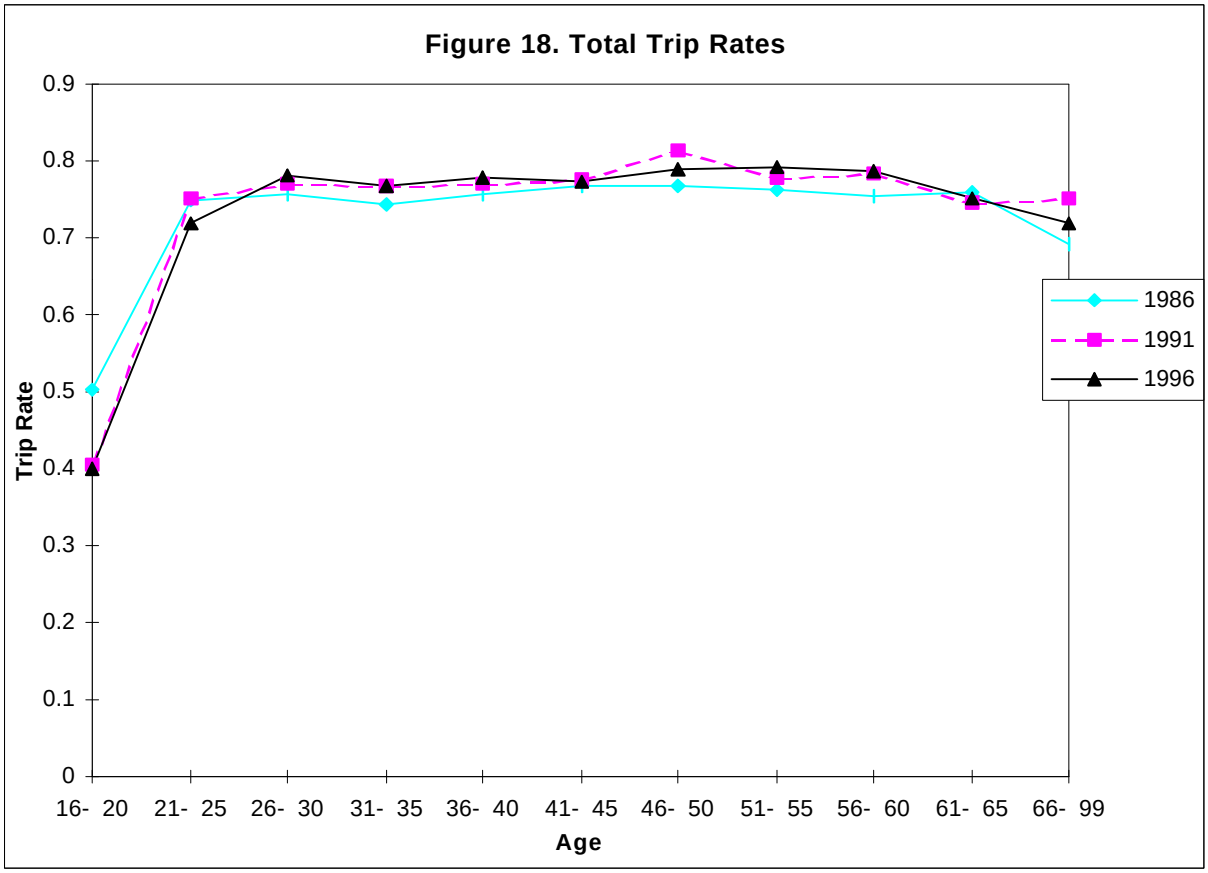
Figure 15. Male Trip Rates
Trip Rate
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
16- 20 21- 25 26- 30 31- 35 36- 40 41- 45 46- 50 51- 55 56- 60 61- 65 66- 99
Age
1986
1991
1996

Figures 16 and 17 again plot 24-hour trip rates by age group, this time categorized by full-time and part-time workers. Full-time trip rates are very consistent across age groups, but have increased slightly over time. Part-time worker trip rates increase consistently with age (older workers clearly must work more days per week on average than younger part-timers), while the overall part-time trip rate has also tended to increase very slightly over time.





The net result in terms of total trip rates per worker working outside the home is shown in Figure 18, in which it is seen that trip rates per worker have remained quite stable over the period 1986-1996. They are also quite similar across age categories, except for the youngest workers (16-20), who are dominated by part-time employment effects.



Figures 19-21 display the fraction of work trips occurring during the morning peak period versus worker age category for females, males and all workers, respectively. The female and male trends are very similar: there has been an across-the-board decline in the peak-period-factor (PPF) over time, and this factor shows little variation by age, except for younger workers -- which, again, reflects a part-time employment effect.

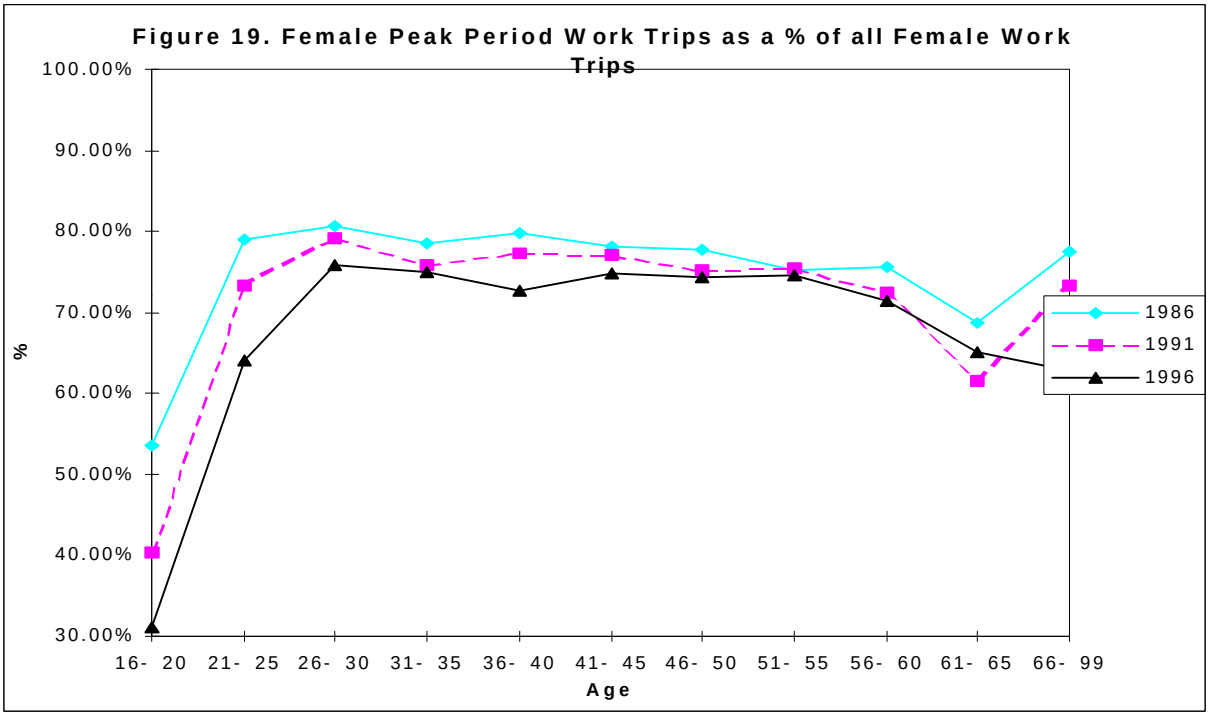


Figure 19. Female Peak Period Work Trips as a % of all Female Work Trips
100.00%
90.00%
80.00%
70.00%
60.00%
50.00%
40.00%
30.00%
%
16- 20
21- 25
26- 30
31- 35
36- 40
41- 45
46- 50
51- 55
56- 60
61- 65
66- 99
Age
1986
1991
1996

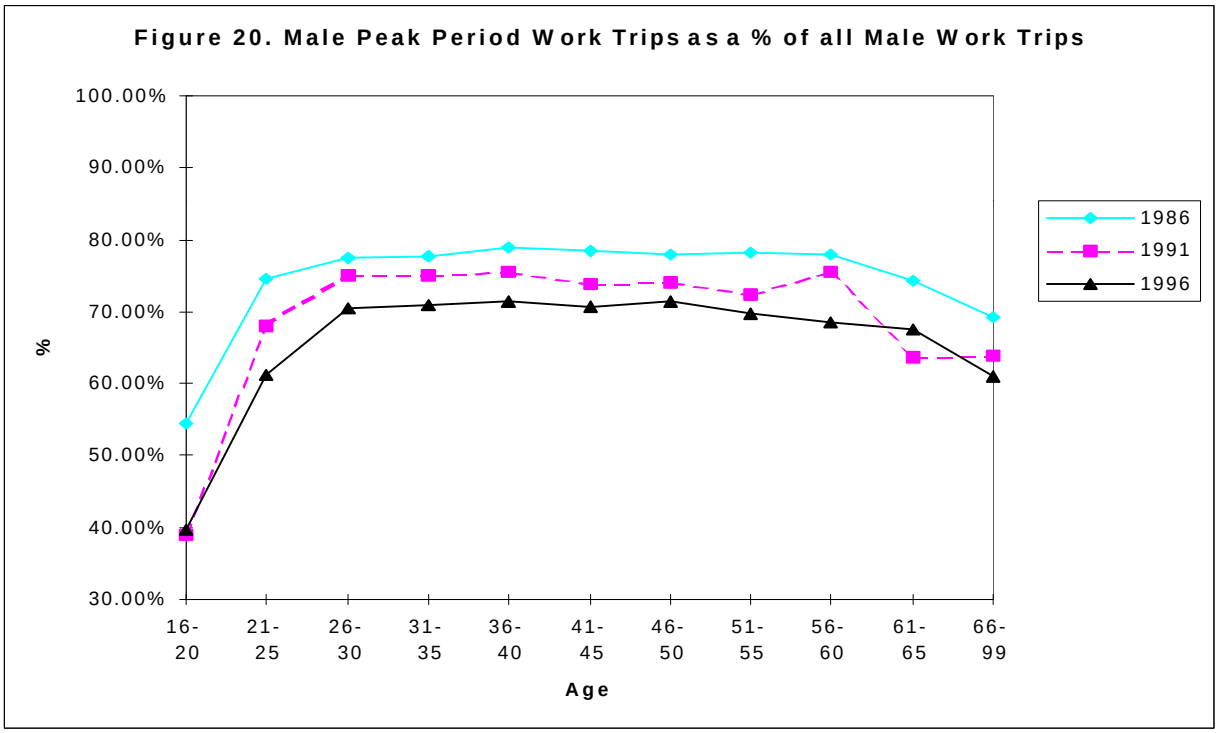
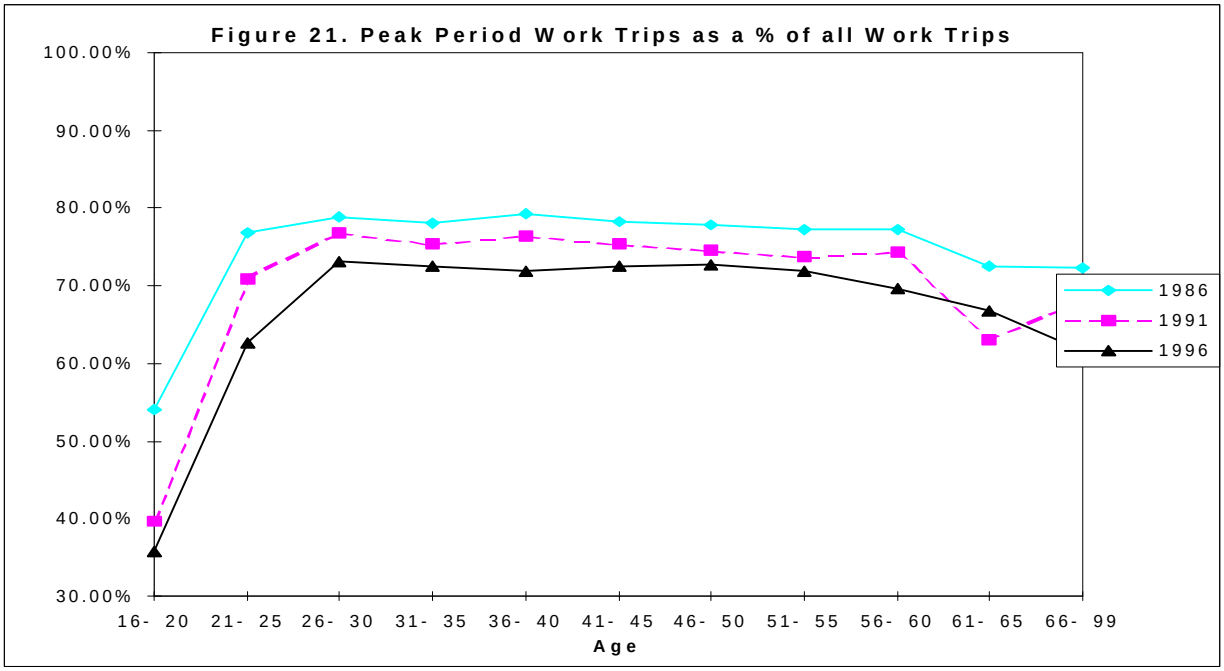


Figure 20. Male Peak Period Work Trips as a % of all Male Work Trips
100.00%
90.00%
80.00%
70.00%
60.00%
50.00%
40.00%
30.00%
%
16-20
21-25
26-30
31-35
36-40
41-45
46-50
51-55
56-60
61-65
66-99
Age
1986
1991
1996



3.2 Summary of Findings

Various observations/conclusions can be drawn from the plots presented above. These include the following:

1. **Labour force participation rates** have declined since 1986. The decline has been more significant for men, particularly those over age 56, and for those in the 21 to 25 age range of both sexes.

2. **Work trip rates per worker employed outside the home** have remained fairly constant over time.

3. The **peak-period-factor** has changed over time, as the morning peak-period has tended to spread and as temporal work patterns change over time.

4. Given points 1 through 3, equation [1] is confirmed as a sensible model of morning peak-period HW trip origins, in which relatively stable 24-hour trip rates per worker (RATE24) can be used, in combination with explicit factors which convert resident population into workers (LFPR, WAH), and which convert 24-hour trips into peak-period trips (PPF).

5. **Observed changes over time in work trip rates per person are largely attributable to changes in labour force participation rates, work at home rates, and the relative age profiles of the resident population**. Age and sex both affect LFPR and (to a lessor extent) WAH. Women are still less likely to be employed full-time than men, while they are more likely to have a part-time job. Female LFPR by age category has largely stabilized, except in the youngest age categories, where young women have been increasingly likely to find part-time rather than full-time employment. Both females and males now exhibit fairly similar full-time LFPR versus age curves which rise sharply until the age of 30, remain quite flat between the ages of 30 and 50, and then fall off again beyond the age of 50.[2] The female and male part-time LFPR versus age curves are also generally similar in shape, except that the female level is significantly higher than the male, and the male rate actually increases somewhat for older men (56-plus), whereas the female rate declines for older women.

6. **Since LFPR is a critical determinant of work trip generation (i.e. it is the factor which converts population into employed workers), and since LFPR varies significantly and systematically with age and sex, ideally one should disaggregate the population inputs to the model by age and sex categories, so that age- and sex-specific LFPR rates such as are shown in Figures 1-4 could be used within the model.** At a minimum, it would be very useful to differentiate between "younger" workers (25 or under), "middle-aged" (25-55), and "older" workers (56 and above). Three points to note with respect to this recommendation are:

   i) We have not yet attempted to quantify the increase in predictive accuracy which this demographic disaggregation would achieve. This is an obvious next step in the analysis. It is hypothesized, however, that it might be significant, and that it might well go a fair way in explaining spatial variations in LFPR.

   ii) The benefits of disaggregating population by age and sex at the traffic zone level may be questionable given the uncertainty associated with forecasts of total population at that level of detail and the inherent volatility of the age distribution. At a more aggregate level, such as by region or municipality, the task is certainly doable, especially given that regional control totals generally exist from regional-level cohort-survival models, given the existence of small area age-sex distributions from census data, and given growing experience with "population synthesis" methods for small zones.[3] As a first step the existing trip generation equation [1] can be modified, replacing the labour force participation rate factor with separate

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2 The female curve still shows a characteristic slight dip in the early thirties, reflecting women leaving the labour force to raise children, but this dip is very minor compared to what it was 10 years or more ago.

3 See, for example, Miller, E.J. "Micro simulation and Activity-Based Forecasting", in Texas Transportation Institute (ed) *Activity-Based Travel Forecasting Conference, June 2-5, 1996: Summary, Recommendations, and Compendium of Papers*, Washington, D.C.: Travel Model Improvement Program, U.S. DOT, U.S. EPA, pp. 151-172,

factors for the proportion of the population in each age group and the applicable participation rate for that group. The modification would be applicable to both the simplified and the full GTA model.

iii) Disaggregating population by age and sex does not necessarily imply doing the same at the employment end. It is quite likely that the outcome would still be simply total trips originating in each zone which are then linked to employment-based trip destinations. It should be noted, however, that a considerable discrepancy exists between the employment forecasts that are currently being used for planning in the GTA and the trends that have been observed between 1986 and 1996. An essential element of travel demand forecasting is the reconciliation of employment forecasts with the labour force participation rate assumptions.

6. Disaggregation by full-time and part-time employment status would also be useful, given that employment status clearly affects trip rates and peak-period factors. It probably also affects trip distribution as well. Given the high correlation between part-time employment and age and sex, however, of the two, the age/sex disaggregation is probably the most immediately useful.

4. POSSIBLE FUTURE TRENDS & THEIR IMPLICATIONS FOR TRIP GENERATION FORECASTING

Taking each of the terms in equation [1] in turn, some implications of the foregoing analysis with respect to possible future trends include the following.

Labour Force Participation Rate: The LFPR term in equation [1] depends on two factors: (1) the age-sex distribution of the population in a given zone; and (2) the relationship between LFPR and the population age-sex distribution, as given by Figures 8-11 (or their equivalents). If population age-sex distributions are at least approximately known for the forecast year, then the first of these factors can be readily accounted for in adjusting future year LFPRs.[4] Shifts in the LFPR versus age-sex relationship, however, are more difficult to project and require considerable judgement in their estimation. As seen in Figures 8-11, over the past 10 years, female LFPR has largely stabilized, while male LFPR has declined. If it is reasonable to assume that female LFPR will remain approximately at current levels in the future, the key question relates to the future levels of male LFPR: will they stabilize at current levels, return to 1986 levels, or will they continue to decline in the future? Plausible arguments may well be possible in favour of each of these assumptions. Thus, considerable care needs to be taken in determining these rates, possibly even to the point of adopting two or three "scenarios" to be tested in the model with respect to this critical variable.

Work at Home Rate: WAH has increased over the past ten years. Given clear trends in increased telecommuting, the emergence of the "virtual office", the rise in self-employed professionals working out of their homes, etc. this factor will almost certainly continue to increase for some time into the future, with the only issue being the magnitude of this increase.

Peak-Period Factor: The percentage of work trips which occur during the morning peak-period has decreased over the past ten years, presumably reflecting the combined impacts of increased peak-period congestion, greater flexibility in working conditions, and the trend to a greater proportion of part-time workers (who generally are less peak-period oriented). This trend is likely to continue, although perhaps at a lower rate of change, given that there presumably is some threshold level below which the PPF is not likely to fall, given the need to maintain "normal business hours", etc.

Work Trip Rate per Worker: As indicated by Figures 14-17, trip rates per worker working outside the home have remained fairly constant over time, especially when categorized by sex (Figures 14 and 15). The major factor affecting these rates appears to be the full-time/part-time split in the labour force, with part-time workers, of course, being less likely to make a work trip on a given day than full-time workers. The trend over the past ten years has been to an increased

4 For example, as the baby boom generation ages, more workers will be retiring than will be replaced by "baby busters" entering the labour force.

proportion of part-time relative to full-time workers (especially among younger workers), reflecting structural changes in the economy. This trend may well continue for at least some time yet, although perhaps (probably?) at a reduced rate. Given the relatively small changes which have been observed in the trip rate per worker despite the shifts in full- to part-time labour (see Figure 18), it may well be the case that relatively little adjustment in current rates are required for future year forecasts **providing** that "appropriate" adjustments in the other factors (as discussed above) have been incorporated.

Table 1 attempts to summarize the above discussion. As shown in this table, it would appear that the most likely trends in most factors affecting work trip generation are such that the work trips per capita will continue to decline in the future. The exact magnitude of this change, obviously, depends on actual values of the projected changes which are assumed for each factor.

Table 1
Summary of Possible Directions of Change in Work Trip Generation Factors

Factor	Direction Change
LFPR	
● % of pop. of working age	↓
● Female rates	≈
● Male rates	?
WAH	↑
TRATE	≈
PPF	↓
Work trips/person	↓?

Legend:
↓ Decrease most likely
↑ Increase most likely
≈ Little change expected