1

A zone in the central building district (CBD) is projected to contain 1,525,000 ft^2 of residential space; 3,675,000 ft^2 of service establishments; and a total-retail activity floor area of 2,100,000 ft^2. Government and other public buildings occupy a total area of 615,000 ft^2. Using the data obtained in Pittsburgh, calculate the trip generation of this zone.

Land-use category	Trips per thousand square feet (From Table 8.2.1)		Area in thousand ft^2 (given)		Trips
Residential	2.4	×	1,525	=	3,660
Service	5.2	×	3,675	=	19,110
Retail	8.1	×	2,100	=	17,010
Public buildings	3.9	×	615	=	2,400
			Total		38,520 person Trips

Number of trips = area in thousand ft^2 × trip rate

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Calculate the total non-work-home-based productions of each of the zones that are expected to contain the following mixtures of households (HH):

Zone 1: Suburban

Persons/HH \ Veh/HH	0	1	2+
1	50	150	100
2, 3	10	500	300
4	100	400	100

Zone 2: Rural

Persons/HH \ Veh/HH	0	1	2+
1	300	50	100
2, 3	100	200	100
4	400	300	150

From table 8.2.3: Total Home-Based-Non-work Trip Rates

Suburban: Medium density

Persons/HH \ Veh/HH	0	1	2+
1	0.97	1.92	2.29
2, 3	2.54	3.49	3.86
4	5.04	5.99	6.36

Rural: Low density

Persons/HH \ Veh/HH	0	1	2+
1	0.54	1.32	1.69
2, 3	1.94	2.89	3.26
4	4.44	5.39	5.76

Product:

Zone 1

Persons/HH \ Veh/HH	0	1	2+
1	49	288	229
2, 3	25	1745	1158
4	504	2396	636
Total	P_1= 7,030 trips		

Zone 2

Persons/HH \ Veh/HH	0	1	2+
1	162	66	169
2, 3	194	578	326
4	1776	1617	864
Total	P_2= 5,752 trips		

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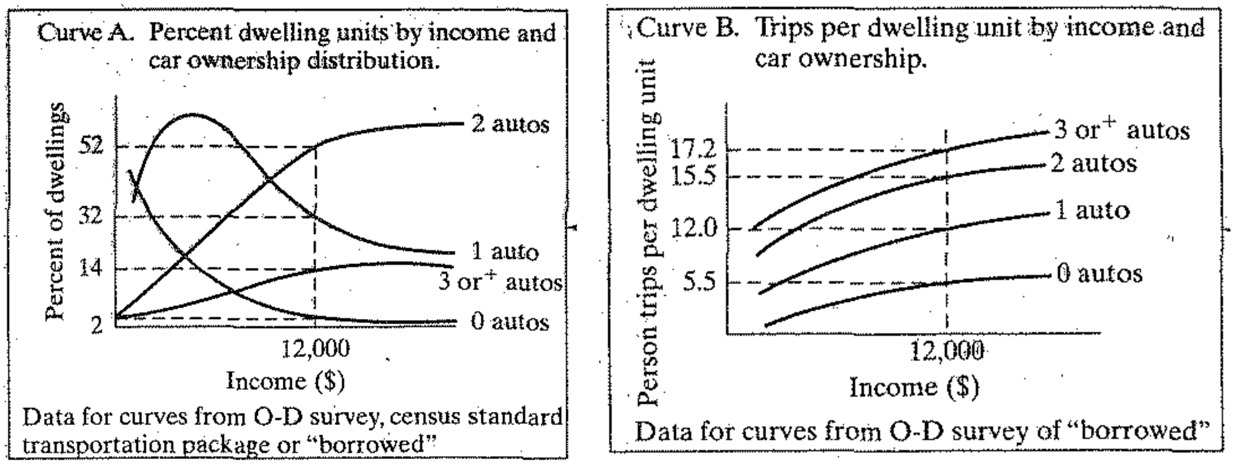
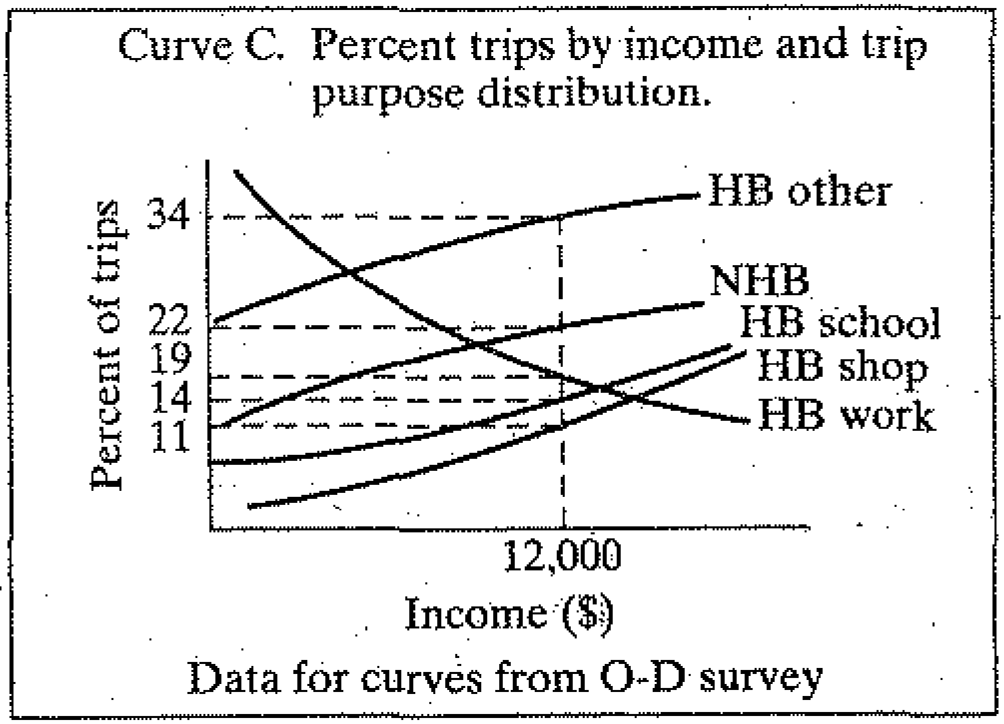
A residential zone is expected to have 1500 dwelling units. For a $12,000 average income, calculate (a) the person-trips per dwelling unit for units that own 0, 1, 2, and 3+ autos and (b) the total-trip generation by trip purpose. Use the income-auto-ownership distribution given in Fig. 8.2.5 and assume that curve C applies to all subgroups within the zone.

(a)



	(A)	(B)	(C)	(D)
Car ownership	% of HHs From Curve A	# of HHs (A) × 1500	Trip Rate From Curve B	Trips (B) × (C)
0	2%	30	5.5	165
1	32%	480	12.0	5,760
2	52%	780	15.5	12,090
3+	14%	210	17.2	3,612
Total	100%	1,500		21,627

(B)



	(A)	(B)
Purpose	% of Trips From Curve C	# of Trips (A) × 21,627
HB Work	19%	4,109
HB Shop	11%	2,379
HB School	14%	3,028
Non-HB	22%	4,758
HB Other	34%	7,353
Total	100%	21,627

■■■■

Zone	Production	Attractiveness
1	1,000	2
2	0	5
3	2,000	1

W_{ij}

I \ J	1	2	3
1	5	20	10
2	20	5	10
3	10	10	5

K_{ij}

I \ J	1	2	3
1	1.1	1.5	0.8
2	0.6	1.2	0.5
3	1.0	1.4	1.3

If the calibration constant c = 1.5, apply the gravity model to calculate all interchange volumes.

Step 1: Identify production zones:

We have two production zones (I = 1, I = 3),

Step 2: Develop a skim table for each one.

$$F_{IJ} = \frac{1}{{W_{IJ}}^c}$$

$$p_{IJ} = \frac{A_J F_{IJ} K_{IJ}}{\sum A_J F_{IJ} K_{IJ}}$$

$$Q_{IJ} = P_I p_{IJ}$$

For I = 1, P_1 = 1,000

J	A_J	W_{IJ}	F_{IJ}	K_{IJ}	$A_J F_{IJ} K_{IJ}$	p_{IJ}	Q_{IJ}
1	2	5	0.0896	1.1	0.197	0.6432	643
2	5	20	0.0112	1.5	0.084	0.2742	274
3	1	10	0.0316	0.8	0.026	0.0826	83
				Total	0.307	1	1,000

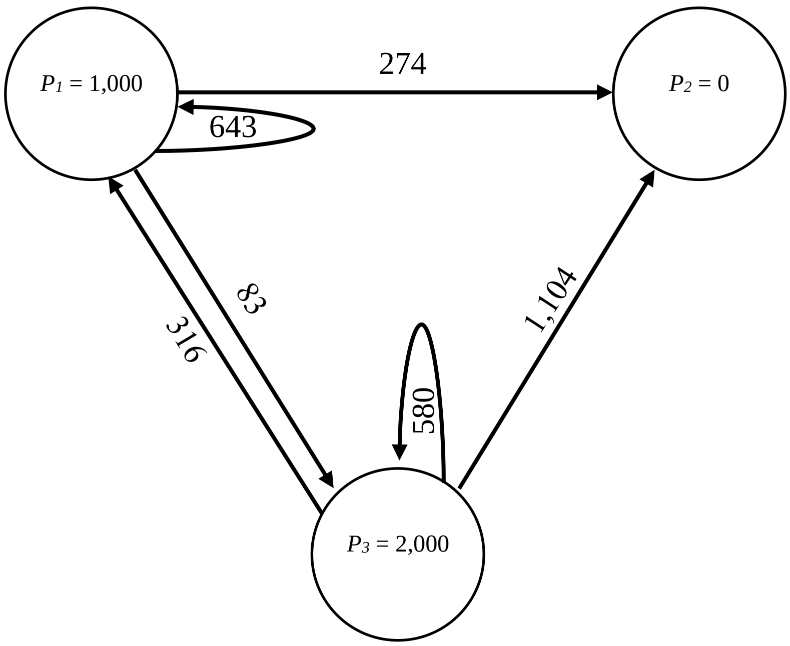
For I = 3, P_3 = 2,000

J	A_J	W_{IJ}	F_{IJ}	K_{IJ}	$A_J F_{IJ} K_{IJ}$	p_{IJ}	Q_{IJ}
1	2	10	0.0316	1	0.0632	0.1578	316
2	5	10	0.0316	1.4	0.2213	0.5522	1,104
3	1	5	0.0894	1.3	0.1162	0.2900	580
				Total	0.4007	1	2,000

Step 3: Summarize in trip matrix.

I \ J	1	2	3	P_I
1	643	274	83	1,000
2	0	0	0	0
3	316	1,104	580	2,000
A_J^*	959	1,378	663	(3,000)

scheme



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Zone	A_J	W_{IJ}	F_{IJ}	Q_{IJ}
1	0	2		
2	400	20		
3	300	5		
4	100	5		
5	200	10		

Complete the above table given that P_1 = 1000 trips per day, c = 2.0 and all K_{IJ} = 1.0.

J	A_J	W_{IJ}	F_{IJ}	K_{IJ}	$A_JF_{IJ}K_{IJ}$	p_{IJ}	Q_{IJ}
1	0	2	0.2500	1.0	0	0	0
2	400	20	0.0025	1.0	1	0.053	53
3	300	5	0.0400	1.0	12	0.631	631
4	100	5	0.0400	1.0	4	0.211	211
5	200	10	0.0100	1.0	2	0.105	105
				Total	19	1	1,000

■■■■

Two residential zones (1 and 2) are expected to produce 6500 and 3800 person trips per day, respectively. Two non-residential zones (3 and 4) are competing for these trips. The planning commission has received a proposal to improve parts of the transportation system, which, if implemented, would affect certain interzonal impedances, W_{IJ}, as shown:

Do nothing

I \ J	3	4
1	10	14
2	8	14

Proposal

I \ J	3	4
1	10	10
2	2	2

Given the following additional information, calculate the effect of the proposal on the total trips attracted by the nonresidential zones.

$F = 38W^{-1.58}$ $\quad A_3 = 10 \quad A_4 = 15 \quad$ all $K_{IJ} = 1.0$

First Choice: Do nothing:

For $I = 1$, $P_1 = 6{,}500$

J	A_J	W_{IJ}	F_{IJ}	K_{IJ}	$A_J F_{IJ} K_{IJ}$	p_{IJ}	Q_{IJ}
3	10	10	1.0	1.0	10	0.53	3,445
4	15	14	0.6	1.0	9	0.47	3,055
				Total	19	1	6,500

For $I = 2$, $P_2 = 3{,}800$

J	A_J	W_{IJ}	F_{IJ}	K_{IJ}	$A_J F_{IJ} K_{IJ}$	p_{IJ}	Q_{IJ}
3	10	8	1.4	1.0	14	0.61	2,318
4	15	14	0.6	1.0	9	0.39	1,482
				Total	23	1	3,800

Trip matrix:

I \ J	3	4	P_I
1	3,445	3,055	6,500
2	2,318	1,482	3,800
A_J^*	5,763	4,537	(10,300)

Second Choice: Proposal:

For I = 1, P_1 = 6,500

J	A_J	W_{IJ}	F_{IJ}	K_{IJ}	$A_J F_{IJ} K_{IJ}$	p_{IJ}	Q_{IJ}
3	10	10	1.0	1.0	10	0.40	2,600
4	15	10	1.0	1.0	15	0.60	3,900
				Total	25	1	6,500

For I = 2, P_2 = 3,800

J	A_J	W_{IJ}	F_{IJ}	K_{IJ}	$A_J F_{IJ} K_{IJ}$	p_{IJ}	Q_{IJ}
3	10	8	1.4	1.0	14	0.40	1,520
4	15	8	1.4	1.0	21	0.60	2,280
				Total	35	1	3,800

Trip matrix:

I \ J	3	4	P_I
1	2,600	3,900	6,500
2	1,520	2,280	3,800
A_J^*	4,120	6,180	(10,300)

Compare A_J^* in both choices:

Choice \ J	3	4
Do nothing	5,763	4,537
Proposal	4,120	6,180

Zone 4 is predicted to attract more traffic. The Lower impedance the higher accessibility.

■■■■

A base-year trip-generation study was calibrated and found the relationship between the daily person-trip productions per dwelling unit (Y) and residential density (X dwelling units per acre).

$$Y = (0.114 + 0.0043X)^{-1}$$

A residential zone I has an area of 500 acres and contains 7,500 dwelling units. Two zones (J and L) are competing for the trips produced by I. Given the following information, calculate the trip interchange volumes Q_{IJ} and Q_{IL} if W_{IJ} = 12, W_{IL} = 8, c = 1.5, A_J = 0.5 A_L, and all K_{IJ} = 1.0.

Density of zone I = 7,500/500 = 15 unit/acre

Trip rate Y

$$\text{Trip rate}, Y = (0.114 + 0.0043 \times 15)^{-1} = 5.6\ trip/unit$$

Trip production P_I = # of units × trip rate = 7,500 × 5.6 = 42,000 person trips

J	A_J	W_{IJ}	F_{IJ}	K_{IJ}	$A_J F_{IJ} K_{IJ}$	p_{IJ}	Q_{IJ}
J	0.5 A_L	12	0.012	1.0	0.006 A_L	0.12	5,040
L	A_L	8	0.044	1.0	0.044 A_L	0.88	36,960
				Total	0.050 A_L	1	42,000

■■■■

Zone	Production	Attractiveness
1	2,000	4
2	0	10
3	0	12

W_{ij}

I \ J	1	2	3
1	5	10	15
2	10	4	10
3	15	10	15

Estimate all interchange volumes assuming that c = 1.9 and that all socioeconomic adjustment factors are equal to unity.

J	A_J	W_{IJ}	F_{IJ}	K_{IJ}	$A_J F_{IJ} K_{IJ}$	p_{IJ}	Q_{IJ}
1	4	5	0.047	1.0	0.188	0.49	980
2	10	10	0.013	1.0	0.126	0.33	660
3	12	15	0.006	1.0	0.070	0.18	360
				Total	0.384	1	2,000

■■■■

The observed and calculated interzonal flow interchanging between *I* and *J* were 2,500 and 2,100, respectively. The data corresponding to the interchange between zones *I* and *L* were 1,960 and 2,060. Given that the total production of zone I was 12,000 trips, calculate the socioeconomic adjustment factors for the two interchanges.

$$K_{IJ} = R_{IJ}\frac{1 - X_I}{1 - X_I R_{IJ}}$$

$$R_{IJ} = \frac{Observed\ Q_{IJ}}{Calculated\ Q_{IJ}}$$

$$X_{IJ} = \frac{Observed\ Q_{IJ}}{P_I}$$

For the link *IJ*:

$$R_{IJ} = \frac{Observed\ Q_{IJ}}{Calculated\ Q_{IJ}} = \frac{2{,}500}{2{,}100} = 1.19$$

$$X_{IJ} = \frac{Observed\ Q_{IJ}}{P_I} = \frac{2{,}500}{12{,}000} = 0.21$$

$$K_{IJ} = R_{IJ}\frac{1 - X_I}{1 - X_I R_{IJ}} = 1.19 \times \frac{1 - 0.21}{1 - 0.21 \times 1.19} = 1.25$$

For the link *IL*:

$$R_{IL} = \frac{Observed\ Q_{IL}}{Calculated\ Q_{IL}} = \frac{1{,}960}{2{,}060} = 0.95$$

$$X_{IJ} = \frac{Observed\ Q_{IL}}{P_I} = \frac{1{,}960}{12{,}000} = 0.16$$

$$K_{IL} = R_{IL}\frac{1 - X_I}{1 - X_I R_{IL}} = 0.95 \times \frac{1 - 0.16}{1 - 0.16 \times 0.95} = 0.94$$

■■■■

Given the utility equation:

$$U_K = a_K - 0.003X_1 - 0.04X_2$$

where X_1 is the travel cost in cents and X_2 is the travel time in minutes.

(a) Calculate the market shares of the following travel modes if the interzonal flow interchanging is 5000 person trips:

Mode	a_K	X_1	X_2
Automobile	– 0.20	120	30
Express bus	– 0.40	60	45
Regular bus	– 0.60	30	55

(b) Estimate the effect that a 50% increase in the cost of all three modes Will have on modal split.

(a)

$$p(K) = \frac{e^{U_K}}{\sum e^{U_K}}$$

$$Market\ share = p(K)Q_{IJ}$$

Mode	U_K	e^{Uk}	*p(K)*	*Market share*
Automobile	– 1.76	0.1720	0.54	2,687
Express bus	– 2.38	0.0926	0.29	1,445
Regular bus	– 2.89	0.0556	0.17	868
		0.3202	1.0	5,000

(b)

If there is a 50% increase in cost, the new values of X_1 for automobile, express bus, and regular bus will be 180, 90, and 45 cents, respectively.

Mode	U_K	e^{Uk}	*p(K)*	*Market share*
Automobile	– 1.94	0.1437	0.51	2,553
Express bus	– 2.47	0.0846	0.30	1,502
Regular bus	– 2.94	0.0531	0.19	945
		0.2814	1.0	5,000

There is a non-significant effect of doubling the cost. A mild shift from automobile to public transit is predicted.

■■■■

Given the utility equation:

$$U_K = a_K - 0.05T_a - 0.04T_w - 0.02T_r - 0.01C$$

where

T_a = access time

T_w = waiting time

T_r = riding time

C = out-of-pocket cost

(a) Apply the logit model to calculate the Shares of the automobile mode (a_K = – 0.005) and a mass transit mode (a_K = – 0.05) if

Mode	T_a	T_w	T_r	C
Automobile	5	0	30	100
Transit	10	10	45	50

(b) Use the incremental logit model to estimate the patronage shift that would result from doubling the bus out-of-pocket cost.

(a)

Mode	U_K	e^{Uk}	$p(K)$
Automobile	– 1.86	0.1565	0.62
Transit	– 2.35	0.0954	0.38
		0.2519	1.0

(b)

Doubling the bus out-of-pocket cost will change C to 100.

Mode	U_K	e^{Uk}	$p(K)$
Automobile	– 1.86	0.1565	0.73
Transit	– 2.85	0.0578	0.27
		0.2143	1.0

There is a significant effect of doubling the transit cost. A significant percentage of transit riders is predicted to shift to automobiles.

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