ECN 145 Lecture 5

Transportation Economics: The Costs of Autos III, Suburbanization, Congestion, and other horrors

Roads and parking spaces use valuable land

- **There are approximately 3 million square miles of land in the United States**
- **2% of this has been paved over for roads**
- **Is this the right level of investment?**
  - What is the opportunity cost?
  - We can't ignore the benefit: good roads make adjacent non-road property more socially useful

Parking and its costs

- **Parking in downtown city centers are often subsidized to bring in business**
- **Example: Ann Arbor, MI (pop. 100,000+)**
  - 4,500 public parking spaces in structures and lots
  - Operating costs of $5.5 million versus revenues of $4.5 million
  - Structure spaces cost $12,000 per space to construct
  - Parking lots/structures sit on prime downtown land worth $500,000 per acre
  - Counting all financing, construction, and opportunity costs, total subsidy runs over $4 million per year

Parking and its costs

- **U.S. government estimates private subsidies to parking amount to $300 billion per year ($3 per gallon of gasoline consumed)!**
- **Shopping centers in suburban locations typically provide so much parking that it is only filled 10-20 hours per year!**

Parking Costs

Land use	Minimum parking spaces
Barber shop	2 per barber
Beauty shop	3 per beautician
Bicycle repair	3 per 1000 square feet
Bowling alley	1 per employee plus 5 per alley
Heliport	5 per touchdown pad
Mausoleum	10 per interments per hour
Nunnery	0.10 per nun
Rectory	0.75 per cleric
Swimming pool	1 per 2500 gallons of water

Road wear and tear

- **Roads are damaged by trucks (and buses), not cars**
  - Road damage depends on cube of weight put on the axle
  - Trucks carry 10 times as much weight as cars
  - So trucks (and buses) do 1000 times as much damage to roads
  - Buses, trucks are not charged anything close to the marginal social cost of their damaging presence on the road – and gas taxes are not a close substitute

TABLE 14.1 Actual and Marginal-Cost Truck Taxes

Truck type	Tax rate per mile	
	Actual	Marginal cost
Standard 3-axle semi	0.071	1.149
4-axle truck-trailer	0.072	0.572
Standard 5-axle semi	0.076	0.222
6-axle semi with trailer	0.086	0.150

Note. The actual tax rate is the U.S. average and includes both fuel taxes and registration fees, converted into a per-mile basis. All vehicles are assumed to have the same gross weight (40 tons) and are assumed to be driven on intercity routes with no congestion.

Source: Small *et al.*, 1989.

Urban traffic congestion is getting worse

- **Example: Manhattan**
  - Nearly 500,000 cars enter daily from New Jersey
  - Traffic during working hours averages only 6 MPH, down from 8 MPH only 6 years ago

More roads are NOT the answer

- **The social cost of more roads**
- **"Triple Convergence" (Downs)**
  - Spatial convergence: drivers who used other routes use the new, expanded route
  - Time convergence: drivers who avoided peak hour traffic now travel during rush hour
  - Modal convergence: drivers switch from public transportation back to driving

Dealing with congestion

- **The obvious answer: tolls**
  - Resisted because they raise the cost of driving for drivers
    - But you have to do that that reduce congestion
  - Resisted because they *create* congestion
    - But technology exists to collect tolls while largely eliminating toll booth queues (FASTRAK)

Dealing with congestion

- **Incentives to carpool**
  - Significant carpooling under WWII gas, tire rationing
  - ¼ of all commuters shared cars during 1970s oil price hikes (versus less than 1/10 today)
- **HOV lanes**
  - This can actually worsen average congestion, since those who don't carpool get crowded into N-1 lanes during rush hour
- **HOT lanes**
  - Allow single-occupant vehicles to use HOV lane by paying a toll; this makes those in N-1 lanes better off, the "HOT" drivers better off, but carpoolers possibly worse off

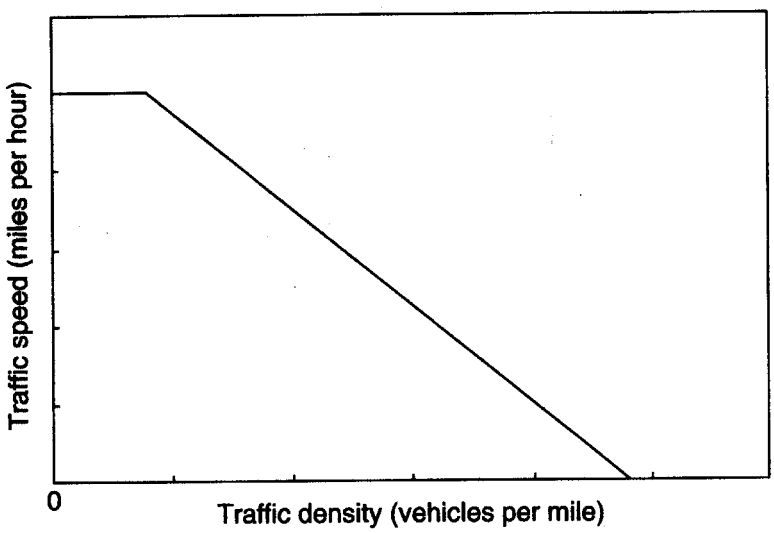


FIGURE 14A.1 Relation of Speed and Density

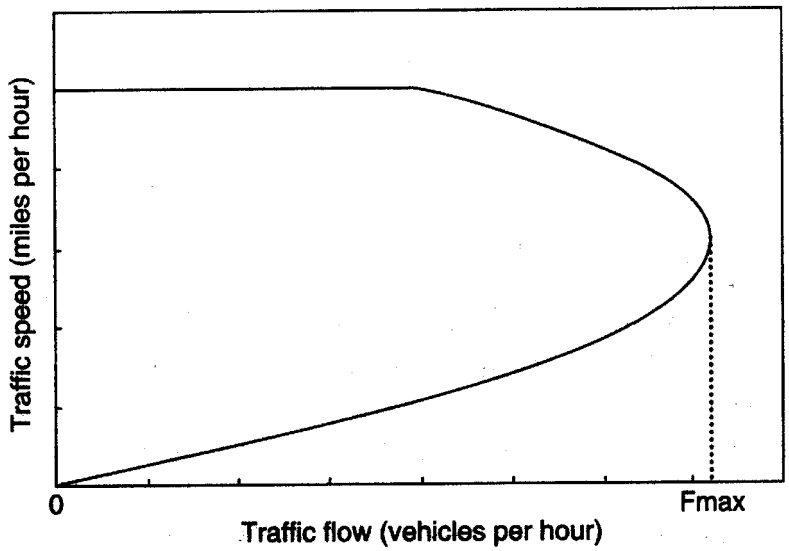


FIGURE 14A.2 Relation of Speed and Flow

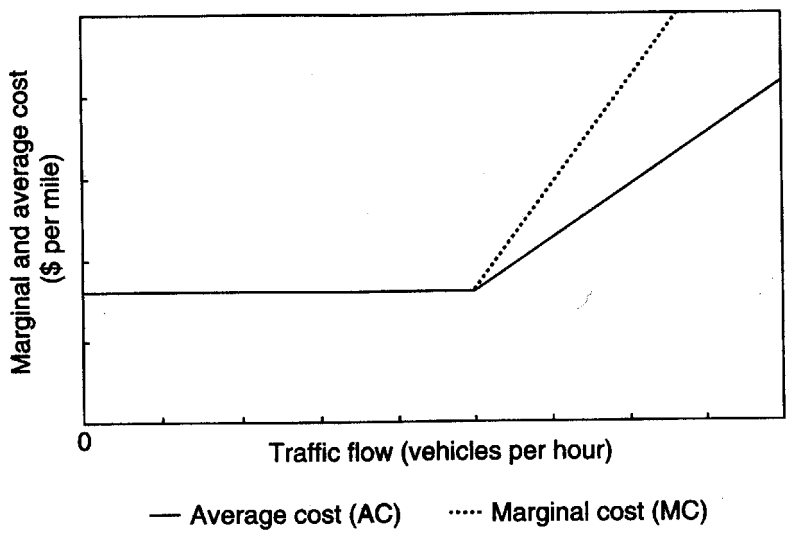


FIGURE 14A.3 Relation of Costs and Flow

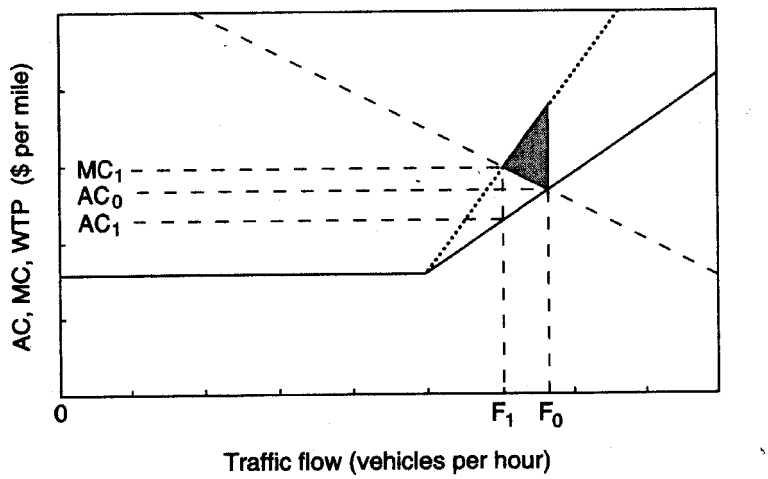


FIGURE 14A.4 Relation of Costs, Demand, and Flow

Why Drivers Hate Tolls

- **Every driver loses in the process**
  - Drivers induced to leave the road are worse off
  - Drivers who continue to use the road pay in money and time what the formerly paid in time (at lower cost)
  - The gains go to the recipients of toll revenue
  - To make the toll palatable for drivers, must find some (indirect) way of rebating part of toll revenues to them

But Tolls are Still Better than Alternative

- **Toll versus HOV-lane**
  - Some drivers will choose to carpool, shifting demand curve for non-HOV lanes to the left
  - But other drivers will choose not to carpool, and congestion will still occur in non-HOV lanes
  - In non-HOV lanes, optimal flow occurs where WTP equals MC, not where it equals AC, and WTP equals MC at a flow that is smaller than the flow where WTP equals AC – the new HOV lanes reduces congestion, but not optimally

Numerical Example of an Optimal Toll

Taken from Box 14A.1 (Porter)

$$S = a - bD$$

$$F = SD$$

$$S^2 - aS + bF = 0$$

Flow (F) (cars/hour)	Optimal toll ($/mile)	Density (D) (cars/mile)	Speed (S) (MPH)
1000	0.01	17	59
2000	0.03	39	51
2500	0.06	54	46
2900	0.21	75	39
3000	0.69	86	35

Note: When there are 86 cars per mile, this means less than 15 yards between cars on average.

Impact of Transportation on Land Use

- **Over time, density of new development in urban areas has fallen**
- **This makes provision of urban public services more expensive, may limit access of poor in central city to new jobs**
- **Leads to alienation, class segregation, and a general absence of the pleasant look and sense of community which characterizes European cities**
- **Al Gore's war against long commutes, rampant development**
- **Are cars to blame for suburbanization? Could transportation policy reverse the trend?**

Effects of Changes in Transport Costs

- **Transport costs determined by**
  - Prevailing technologies
  - Cumulative value, spatial configuration of transport infrastructure
  - Public policies governing use of transport infrastructure
- **Transport costs have two components**
  - Monetary costs of passenger/freight movements
  - Economic value of time/inventory cost of goods in transit

Household Location/Residential Development

- **Technological developments that lower transport costs**
  - Reduce the rate at which commuting costs rise with distance from workplace
  - Induces households to seek more distant, lower-density residential locations
- **The collective effect of household relocations**
  - Perimeter of urban development moves outward
  - Population density decline becomes less pronounced
- **Unrealistic implication of our model**
  - Fails to account for the "burden of history"

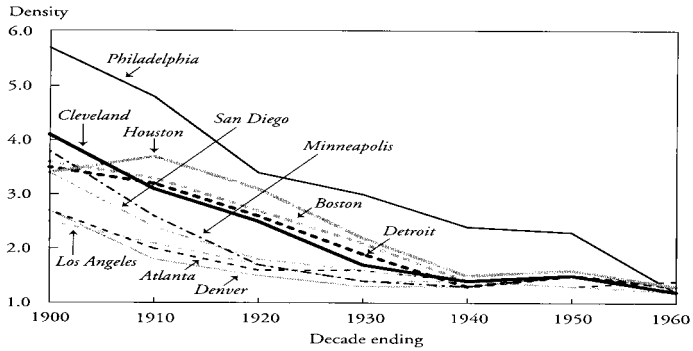
Firm Location/Employment Distribution

- **Firm location depends on how innovation or investment affects relative magnitudes of passenger and freight travel costs**
  - Developments which lower freight costs by more than commuting costs preserve centralized employment
  - Developments which reduce travel costs for people relative to those of goods lead to dispersion of employment as well as households

Transportation's Influence on Urban Land Use

- **Residential Development**
  - Rising incomes and changes in the size and composition of households have increased demand for low-density (suburban) residences
  - Auto technology, investment in urban-suburban expressways have lowered the cost of commuting from distant suburbs
  - This had led to a dramatic decrease in density of new residential development in metropolitan areas in the United States

Figure 12-1. *Density of New Residential Development by Decade for Selected Cities, 1900–1960*



Source: U.S. Census of Housing: 1940, Characteristics by Type of Structure: 1950, vol. 2, by City, table A-6; 1960, vol. 2, by City, table A-6. Density is measured by the reciprocal of the share of new dwellings that are single-family detached houses. After 1960 most of the lines cluster together at about the same value, although some rise to about the 2.0 value by 1980.

Transportation's Influence on Urban Land Use

- **Employment Decentralization**
  - Economies of scale and network design characterized early advances in freight (canals, railroads) and passenger (street trolleys, rail rapid transit) transportation, leading to centralization of employment in the urban core
  - More recent advances (trucks, autos) have reduced advantages of centralization
  - Transition to a service economy has probably accelerated the de-centralization of urban employment (example of the Internet)
  - Agglomerations rivaling the "downtown" have developed at major highway interchanges and along circumferential highways

Transportation's Influence on Urban Land Use

- **The modern influence of transportation**
  - Studies show that commuting times are longer, transport costs less important than other variables in influencing firms' location decisions
  - Successive improvements in transportation technologies have brought successively smaller reductions in travel times
  - Successive waves of investment in urban transportation have also brought successively lower improvements in travel speeds and trip times

Table 12-1. *Effects of Technological Innovations on Travel Speeds and Times*

Technology	*Approximate date introduced*	*Typical door-to-door speed (mph)*[a]	*Travel time per mile (minutes)*
Walking	Early	3	20
Horse-drawn omnibus	1827	4	15
Horse-drawn streetcar	1835	5	12
Cable car	1875	8	7.5
Electric streetcar	1890	10	6
Rail rapid transit	1910	15	4
Motor bus	1915	20	3
Automobile	1920	30	2

Source: Author's calculations based on Weiglin (1976).

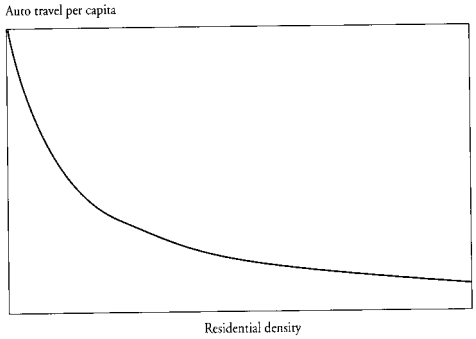
a. Typical door-to-door speed differs from operating speed because it includes access to transit stops, waiting, transfers, and so forth; the data are for all trips using the technology not just commuting.

The Effect of Land Use on Travel Behavior

- **There is a widely noted empirical association between residential density and measures of auto use**
  - But analysts must carefully control for household income, residential effects
- **The actual linkage degree to which changes in residential density could cause changes in auto use is probably quite small**
  - Studies with appropriate controls suggest no significant decline in auto use at densities American suburbs are actually likely to reach

Auto Use and Residential Density

Figure 12-3. *Hypothesized Relationship of Auto Use to Residential Density*



Source: Newman and Kenworthy (1989a).

Auto Use and Residential Density

Table 12-2. *Estimated Effects of Residential Density on Travel Behavior*

Source	Variables controlled for:	Travel measure	Estimated elasticity of measure at residential density of: 2,000/sq. mi.	5,000/sq. mi.	10,000/sq. mi.
Oi and Shuldiner (1962)	Household size	Daily person-trips/dwelling unit	< –0.01	< –0.01	< –0.01
	Household income	Daily person-trips/dwelling unit	–0.05	–0.05	–0.05
Cheslow and Neels (1980)	Household income	Household auto ownership	–0.08	–0.08	–0.08
	Household size	Average automobile trip length	–0.04	–0.04	–0.04
	Auto ownership	Daily vehicle trips per household	–0.15	–0.15	–0.15
	Travel speeds	Proportion of trips by transit	0.11	0.29	0.57
	Transit service				
Schimek (1996)	Household income	Annual VMT per household	–0.28	–0.22	–0.22
	Household size	Household vehicle ownership	–0.11	–0.24	–0.39
	Race and ethnicity	Annual VMT per household	–0.13	–0.28	–0.43
	Urban area size				
	Geographic region				
Pickrell and Schimek (1996)	Household income	Daily VMT per capita	–0.32	–0.55	–0.89
	Household size	Proportion of all trips by auto	–0.17	–0.24	–0.45
	Race and ethnicity				
	Urban area size				
Pickrell and Schimek (1997)	Household income	Daily VMT per capita	–0.15	–0.15	–0.15
	Household size	Annual miles driven per vehicle	–0.05	–0.05	–0.05
	Race and ethnicity				
	Urban area size				

Sources: Author's calculations based on results reported in individual references. VMT = vehicle miles traveled.

Evidence from International Comparisons

- **Until fairly recently, suburbanization and auto "overuse" were believed to be a uniquely American phenomenon due to**
  - Tax, pricing policies favorable to car ownership, use
  - The Federal Interstate Highway construction program and the Highway Trust Fund
  - Federal tax/mortgage policies that support home-ownership and effectively subsidize suburban residential development
  - Political fragmentation and powerful local governments that allow suburbanites to escape urban social and fiscal problems

Evidence from International Comparisons

- **The presence of different patterns of urban development in Europe, Japan raised the possibility that different land use, auto policies might alter pattern of U.S. residential development**
  - Broadly similar economic, technological trends affecting other developed nations
  - Suggested purely economic factors were not behind "American-style" suburbanization

Evidence from International Comparisons

- **But recent evidence from Europe, elsewhere, suggests a global trend towards urban decentralization, increased reliance on autos due to**
  - Rising affluence
  - Declining household size and increased participation of women in the workforce
  - Employment and residential decentralization

TABLE 3 Mode Share Trends, All Person Trips, Selected Urban Areas

London	1975-76	1985-86	1989-91
Car	41	44.3	47.8
Public Transport	20	17.5	17.0
Bike	3	2.8	1.7
Walk	35	35.0	32.7
Manchester [a]	**1971**	**1981**	**1991**
Car	32	50	64
Public Transport	39	24	16
Bike	2	2	2
Walk	21	19	16
Norwegian city regions	**1970**	**1985**	**1990**
Car	32	60	68
Public Transport	20	11	7
Walk & Bike	48	29	25
W. Germany urban areas	**1972**	**1982**	**1992**
Car	34	43	49
Public Transport	17	17	16
Bike	8	10	12
Walk	41	30	23
US urban areas	**1969**	**1977**	**1990**
Car	79.8	82.3	84.3
Public Transport	4.9	3.4	2.8
Bike	0.7	0.7	0.7
Walk	11.5	10.7	9.1

[a] Journey to work only

Source. Pucher and Lefevre (1996); Hervick, Tretvik and Ovstedal (1993); Brog and Erl (1995).

Evidence from International Comparisons

TABLE 5 Population and Employment Decentralization in Selected European Cities Average Annual Percentage Change

	Population			Employment		
City	Years	Core City	Suburbs	Years	Core City	Suburbs
Antwerp	1970-81	-0.8	+1.2	1974-84	-0.7	+0.4
Copenhagen	1970-85	-1.5	+1.0	1970-83	-0.3	+3.2
Hamburg	1970-81	-0.8	+1.9	1961-83	-0.8	+1.9
Liverpool	1971-80	-1.6	-0.4	1978-84	-2.6	-3.1
Milan	1968-80	-0.6	+1.3	1971-81	-0.9	+1.9
Paris	1968-80	-1.1	+1.1	1975-82	-1.1	+0.9
Rotterdam	1970-80	-1.6	+2.2	1975-84	-1.1	+1.5

Source: Jansen (1993)

A Pedestrian-Friendly Future?

- **Emerging "pedestrian-friendly" neighborhoods – the "New Urbanism" architectual movement**
- **But these are typically located in upper middle class suburbs a long way from the urban core**
- **The future belongs to the car**

A Pedestrian-Friendly Future?

- **Most firms have no economic incentive to locate in dense, high cost centers**
- **Globalization makes it increasingly difficult to impose controls on where firms locate**
- **Most households have no incentive to locate in dense, high cost centers**
- **Density policies required to achieve reductions in private vehicle use have no political constituency**
- **Density policies that could be implemented will be swamped by larger trends**

Accessibility and Economic Opportunity

- **Has the decentralization of jobs disproportionately affected the poor and racial minority groups?**
  - McCone Commission, established in wake of the ’65 Watts riots in LA, said, “Yes.”
  - Subsequent careful social science by urban economist John Kain, transportation guru John Meyer confirmed this

Accessibility and Economic Opportunity

- **Limited low-cost housing available in the suburbs**
- **Legacy of racial segregation, housing market discrimination increases mobility problems for minority households**
- **Income constraints on poor households limit their commuting options**
- **Influential early study by Kain (1968) suggested that the absence of residential segregation alone would generate 25,000 jobs for African Americans**

Accessibility and Economic Opportunity

- **Postwar trends have continued since 1970**
  - Jobs (especially low-skilled jobs) have continued to migrate from central cities
  - The African-American population remains much more concentrated in central cities than whites of similar income levels
  - The transportation options of poor households remains limited

Accessibility and Economic Opportunity

Table 13-1. *Centralization of Jobs and Workers, 1970 and 1990*

	Percent working in central city		*Percent living in central city*		*Central city jobs per central city worker*	
Workers	*1970*	*1990*	*1970*	*1990*	*1970*	*1990*
All	50.9	23.4	46.5	18.0	1.09	0.93
White	49.6	20.2	42.3	13.1	1.17	1.00
Black	60.7	36.9	79.2	37.2	0.77	0.70

Sources: Census Bureau (1973: table 26); Census Bureau (1992).

Table 13-2. *Central City Jobs in Industries in which the Average Education of Employees is More than or Less than Twelve Years*
(thousands, unless noted)

City	*1970*	*1990*	*Job change*	*Percent change*
Atlanta				
Less than 12 years	179	190	+11	+6.1
More than 12 years	92	165	+73	+79.3
Baltimore				
Less than 12 years	207	110	+97	–46.9
More than 12 years	90	118	+28	+31.1
Boston				
Less than 12 years	189	128	–61	–32.3
More than 12 years	185	237	+52	+28.1
Dallas				
Less than 12 years	337	468	+131	+38.9
More than 12 years	107	334	+227	+212.1
Denver				
Less than 12 years	120	107	–13	–10.8
More than 12 years	72	120	+48	+66.7
New York				
Less than 12 years	1,552	977	–575	–37.0
More than 12 years	1,002	1,253	+251	+25.0
Philadelphia				
Less than 12 years	430	226	–204	–47.4
More than 12 years	205	231	+26	+12.7
San Francisco				
Less than 12 years	132	173	+41	+31.1
More than 12 years	135	204	+69	+51.1
St. Louis				
Less than 12 years	210	107	–103	–49.0
More than 12 years	98	79	–19	–19.4

Source: Computed from data reported in Kasarda (1995).

Table 13-3. *Workplace and Residential Location of Metropolitan Area Workers in 1970, by Race and Poverty Status*
(percent)

	Nonpoverty households living in		*Poverty households living in*	
Work in	*Central city*	*Suburb*	*Central city*	*Suburb*
All workers				
Central city	36.4	18.1	48.5	10.7
Suburb	8.8	36.7	9.2	31.7
White workers				
Central city	33.4	19.3	43.0	12.1
Suburb	8.1	39.1	8.1	36.8
Black workers				
Central city	62.9	7.0	64.0	6.8
Suburb	12.2	17.9	15.3	13.9

Source: Census Bureau (1973: table 26).

Table 13-4. *Workplace and Residential Location of Metropolitan Area Workers in 1990, by Race and Poverty Status*

(percent)

	Nonpoverty households living in			*Poverty households living in*		
Work in	*Central city*	*Inter-mediate*	*Suburb*	*Central city*	*Inter-mediate*	*Suburb*
All workers						
Central city	15.9	2.7	11.1	24.6	1.4	5.6
Intermediate	2.9	30.8	9.3	4.2	36.0	5.4
Suburb	3.4	1.8	22.1	4.5	2.0	16.5
White workers						
Central city	12.3	3.0	11.5	16.3	1.8	6.0
Intermediate	2.4	34.0	10.4	2.8	43.4	6.5
Suburb	0.3	2.9	23.3	2.9	2.2	18.2
Black workers						
Central city	33.4	1.6	9.7	35.6	1.1	4.2
Intermediate	5.2	23.3	4.6	5.3	34.2	3.4
Suburb	5.4	1.6	13.3	4.8	1.2	10.3

Source: Census Bureau (1992).

Accessibility and Economic Opportunity

- **But more recent empirical studies have cast doubt on the link between transportation costs and economic opportunity**
  - Measures of "spatial access" do not explain employment outcomes for poor minority youths
  - Apparent link between transportation and economic opportunity seems to be driven by "neighborhood effects"
    - The role of informal employment information dissemination through friends, relatives, other personal contacts

Accessibility and Economic Opportunity

- **Three policy alternatives**
  - Move jobs to people (redevelop the urban core)
    - Flies in face of global trends pushing urban decentralization – may not be economically viable
  - Move people to jobs (integrate the suburbs)
    - Experiments with this suggest that moving the urban poor to the suburbs makes them better off, but any such movement on a large scale will be staunchly resisted – may not be politically viable
  - Improve the movement of central city residents to suburban jobs (improve transportation access)
    - Experiments with improved bus service, other transportation improvements suggest gains of transportation policy alone will be quite meager

Accessibility and Economic Opportunity

- **The best "transportation access" policy: give the poor a car**
  - Studies show that poor job-seekers who own cars search over a wider area, often finding better opportunities
  - Experiments in providing the poor access to cars has had some initial success
  - Kentucky's example: fleets of cars donated to welfare recipients are inspected, repaired, and maintained by vocational students as part of auto mechanic training courses
  - But the "transportation access" dimension is a small part of the problem