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Buses, Trains, and Automobiles: Finding the Right Transportation Mix for the Phoenix Metro Region

by John Semmens, Transportation Policy Analyst, Laissez Faire Institute

EXECUTIVE SUMMARY

The Maricopa Association of Governments (MAG) has proposed the continuation of a half-cent sales tax beginning in 2005, the proceeds of which would be spent on a wide range of transportation measures for Maricopa County. Public transit plays a key role in the plan, with about 14 percent of sales tax revenues dedicated to the construction of light rail in the Valley and 16 percent dedicated to various forms of bus transit.

MAG's public transit plans deserve close scrutiny. Use of urban public transportation systems has been in decline since the end of World War II, when public transit provided 50 percent of urban travel. Last year, only three percent of urban travel in America was provided by public transit. This decline has occurred despite prodigious government efforts to prevent it. Governments now spend 30 to 40 times as much on public transit as for roadways. But evidence suggests that transit is not the most effective use of public transportation dollars.

Of all the options in the public transit mix, light rail deserves the most scrutiny. Because it requires its own special track, it lacks the flexibility of buses, which use existing city streets. And because tracks would be constructed on existing city streets, light rail in the Phoenix region is actually projected to increase traffic congestion. Furthermore, in no city in America does light rail transit account for much more than one percent of urban person-miles of travel. The Phoenix light rail system is projected to account for only two-tenths of one percent of travel in the region.

The average cost of light rail per passenger-mile is around $1.50, almost double the cost of bus transit, and five times the cost of automobile transportation per vehicle-mile. On average, taxpayers pay nearly 90 percent of the cost of light rail passenger travel, considerably more than for all other transit modes. Worst of all, light rail would do almost nothing to relieve traffic congestion. Because 80 percent of new light rail passengers in Maricopa County would be former bus passengers, light rail would remove less than one car in 1,000 from traffic.

Instead of squandering taxpayer money on light rail, the Valley should focus transit dollars on bus transit. Better yet, the Valley should work to expand freeways and improve the efficiency of freeway use through measures such as congestion pricing.

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Per person-mile of travel, government now spends 30 to 40 times as much on public transit as it does for roadways. Despite generous taxpayer subsidies, transit systems in Phoenix and other American cities carry only a small fraction of total person-miles of travel.

Introduction

In August 2003, the Maricopa Association of Governments (MAG) submitted the final draft of its comprehensive Regional Transportation Plan for Maricopa County. MAG proposes a continuation of the county's half-cent sales tax beginning in 2005, the proceeds of which would be spent on a wide range of transportation measures. Public transit plays a key role in the plan, with about 14 percent of the sales tax revenues dedicated to the construction of light rail in the Valley, and 16 percent dedicated to various forms of bus transit. MAG is trying to put the plan on the county ballot on May 4, 2004.

MAG's public transit plans deserve close scrutiny by Maricopa County voters and policymakers. Of all the options in the public transit mix, light rail deserves the most scrutiny.

The Decline of Public Transit

Use of urban public transportation systems has been in decline since the end of World War II. At that time, public transit vehicles provided 50 percent of travel in urban regions. Last year, about three percent of urban travel in America was provided by public transit. The decline of public transit is the result of powerful demographic forces that show no sign of reversal. Because the demand for public transit is inversely related to personal income, as people's incomes rise they can afford the more comfortable and convenient travel provided by owning and operating an automobile.

The decline of public transit in America has occurred despite prodigious government efforts on all levels to prevent it. Transit statistics for Phoenix and for the nation tell a tale of inefficiency, inequity, and ineffectiveness. Because of heavy public subsidies, nonriders tend to pay three-fourths of the cost of every transit user's ride. Per person-mile of travel, government now spends 30 to 40 times as much on public transit as it does for roadways. Governments have done little to generate compensatory revenues from customers, resulting in massive operating losses. Despite generous taxpayer subsidies, transit systems in Phoenix and other American cities carry only a small fraction of total person-miles of travel.

Light Rail: The Worst Transit Option

Light rail is a key element of the MAG transportation plan for Maricopa County. However, light rail's performance in cities across the country suggests that it is probably the worst of all the options in the proposed public transit mix.

Proponents of light rail transit in the Phoenix metropolitan area point to cities such as Portland and San Diego as exemplars of light rail implementation.[1] But a comprehensive look at performance measures in those and other cities shows that light rail systems have failed to yield even marginal returns on city investments. There is no light rail transit system in America in which fares paid by passengers cover the cost of their rides, and the aggregate nationwide deficit for light rail exceeded $1.4 billion dollars in 2000, the last year for which figures are available. The average cost of light rail transit per passenger-mile is $1.48, nearly double the cost per passenger-mile for bus transit, which is 78 cents. Light rail requires its own special track, at a cost of around $40 million per mile to build, so it lacks the flexibility of buses, which use existing city streets. And the cost of light rail is roughly five times that of automobile transportation, which is 29 cents per vehicle-mile.

Light rail proponents argue that it will reduce urban traffic congestion by luring drivers out of their cars and into the transit system. But in no city in America did light rail transit account for much more than one percent of the urban person-miles of travel. The average share of person-miles of travel for light rail was only three-tenths of one percent. If all light rail passengers had previously driven their own cars, light rail would remove, on average, three cars in 1,000 from the roads. However, studies have shown that about 80 percent of new light rail passengers are former bus passengers. Taking that into account, the real impact of light rail is to remove less than one car in 1,000 from traffic.

Light rail also results in a massive redistribution of resources from nonriders to riders. When all transit modes are considered, riders pay about one-fourth of the costs, with taxpayers absorbing the other three-fourths. But for light rail, taxpayers pay nearly 90 percent of the costs. Light rail compares even more unfavorably with auto transportation, where private passenger vehicles pay around 100 percent of their share of the cost of the road system.

The performance of a Phoenix light rail system is projected to be worse than the average for other American cities. Phoenix-area passengers are projected to pay only five percent of the cost of their rides, and the light rail system is projected to account for only two-tenths of one percent of travel in the region. Because the rail lines will be constructed on existing city streets, light rail in the Phoenix region is projected to actually increase traffic congestion in the Valley, and at best it will have a negligible impact on air pollution.

Given a performance that is inferior to those of other transit options, light rail is the most unappealing choice for trying to meet the needs of the small fraction of urban travelers who rely on public transportation.

Better Alternatives

Modern urban travelers want convenience, comfort, and speed. The

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Given the predominance of the automobile and the wastefulness of public transit options, Maricopa County voters and policymakers should examine more realistic and productive approaches to meeting transportation needs, reducing traffic congestion, and improving air quality.

automobile best fits those requirements, which is why it is the choice of the overwhelming majority of urban travelers. The inconvenient and slower transportation offered by public transit modes does not meet the needs of more than a small fraction of urban travelers. Given the predominance of the automobile and the wastefulness of public transit options, Maricopa County voters and policymakers should examine more realistic and productive approaches to meeting transportation needs, reducing traffic congestion, and improving air quality.

First, Maricopa County should focus resources on improving its road system. Options include building more freeways, improving traffic signal coordination, and replacing existing highway taxes with congestion-based pricing. Another option in use in other states is to convert underused high-occupancy-vehicle (HOV) lanes into high occupancy/toll (HOT) lanes. This practice effectively rents unused HOV capacity to single occupant vehicles.

Second, the county should implement cost-effective alternatives to driving alone. Options include encouraging commuter carpooling, restructuring public transportation through the use of competitive provision and efficiency pricing, and promoting privately operated subscription buses. Third, the county could encourage more innovative employment practices, including a compressed work week, flextime, proximate commuting, and telecommuting. Finally, the county should consider the use of alternative measures for improving air quality. There are several ways to target the relatively few super-emitting vehicles that cause the most pollution. In addition, mobile emission enforcement can help to overcome the problem of high-polluting vehicles that test clean during stationary annual inspections.

A National Perspective on Transit

The transit options proposed by cities in Maricopa County are not unique, so this report begins with a look at transit from a national perspective. Observing the performance of transit in the aggregate and in other individual cities provides a foundation for evaluating the proposals offered for the Phoenix region.

A Declining Industry

Public transit is clearly a declining industry. Ridership peaked around World War II at 23 billion trips per year.[2] World War II provided optimal conditions for transit ridership. More than 10 million young men were away from home, enlisted, or drafted into the U.S. armed forces. Few of them owned or could use automobiles. Auto manufacturing was discontinued and auto manufacturing plants converted to producing military vehicles. Gasoline was rationed, which discouraged the use of autos by persons who did own them. Under those conditions, public transit was able to capture 50 percent of the urban passenger miles of travel.[3]

As World War II came to an end and life returned to a more normal peacetime mode, public transit lost most of its market advantages. Ridership declined by about two-thirds, from 23 billion annual trips to between nine and 10 billion in recent years (see Figure 1).[4] Public transit's share of urban passenger miles fell from 50 percent in 1945 to barely three percent by 2001 (see Table 1 and Figure 2).[5]

Rising personal income increases the ability of families to own automobiles and houses. Residents without vehicles living in densely populated urban centers are likely customers for public transit. Auto-owning families, living primarily in suburbs, are not. Public transit is what economists refer to as an inferior good. For a normal good, the quantity consumed rises as people's incomes rise. For an inferior good, the quantity consumed falls as people's incomes rise. Per capita personal income in the United States rose from $1,223 in 1945 to $30,069 by 2000. Adjusting for inflation between 1945 and 2000, real per capita purchasing power increased by about 150 percent.[6]

As family incomes rose in the post World War II era, consumers shifted their demand from transit to automobiles as the preferred mode of travel. Once an auto is owned, the heavy fixed costs of ownership (depreciation, insurance, and financing) argue in favor of extending the use of the vehicle as much as possible. Consequently, it should not be surprising to find that transit trips per capita fell from 175 in 1945 to 33 in 2000, a decline of over 80 percent.[7] In central cities, over 90 percent of travel is in cars.[8] Even among the poorest segments of the U.S. population, a majority of travel is in cars. In the $15,000-and-under annual income category, 80 percent of travel is by car, with less than 10 percent via public transit.[9] Moreover, those with incomes under $15,000 constitute a

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Figure 1. Number of Transit Trips

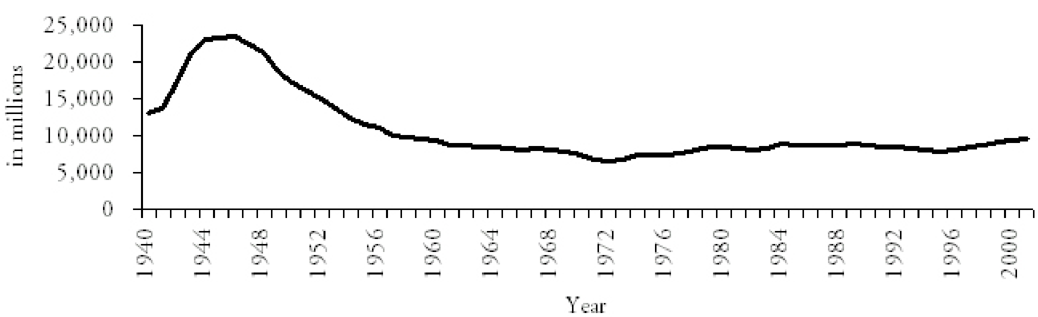
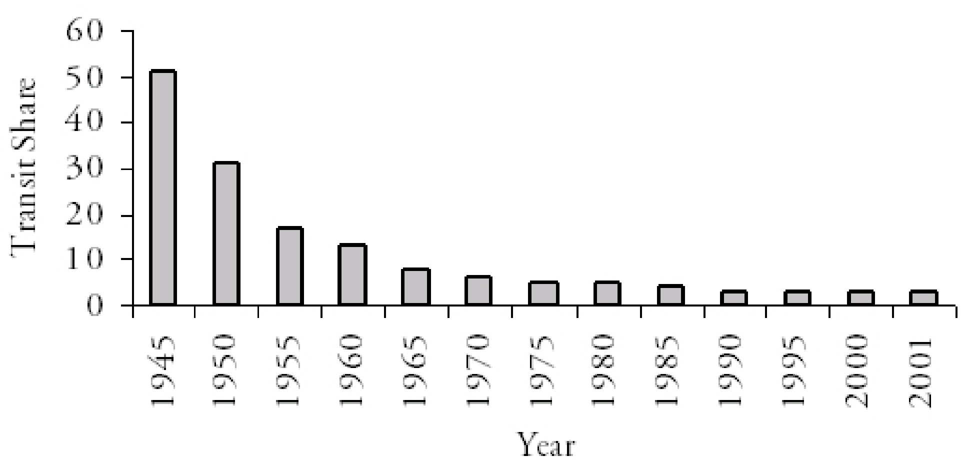


Table 1. Transit's Share of Urban Travel

Year	Transit passenger-miles (in billions)	Automobile vehicle-miles (in billions)	Transit share (percent)
1945	112	109	51
1950	84	183	31
1955	56	267	17
1960	46	309	13
1965	38	420	8
1970	34	545	6
1975	34	691	5
1980	40	813	5
1985	40	995	4
1990	41	1,217	3
1995	40	1,409	3
2000	47	1,570	3
2001	49	1,582	3

Source: Alan Altshuler, "Changing Patterns of Policy: The Decision Making Environment of Urban Transportation," *Public Policy* (Spring 1977), 171-203; American Public Transit Association, *Public Transportation Fact Book* (1945-2001); and Federal Highway Administration, *Highway Statistics* (1945-2001).

Figure 2. Transit's Share of Urban Travel



minority of transit riders.[10] The most costly and worst-performing segments of most transit systems are the long-haul routes that extend into the suburbs to serve the more affluent employees of downtown businesses.[11] Far from being a program oriented toward helping the poor, most of the expense in public transit is incurred serving those who would appear quite capable of bearing the cost of their own transportation.[12]

Financial Performance

So powerful are the demographic trends affecting public transit that massive subsidies from the federal government have failed to stem the decline. In 1964, the first Urban Mass Transportation Act was passed. At that time about nine percent of urban person miles of travel were made on public transit. Today, only three percent of urban person miles of travel are made via transit (see Table 1). Since the federal government became involved in subsidizing local public transit in 1964, over $100 billion has gone into those systems. Over this same time period, local governments have put over $265 billion into subsidizing public transit systems. Despite that massive investment, per capita transit trips have declined from 43 in 1965 to 33 in 2000.[13] Also, the aggregate financial performance of public transit is the worst it has ever been. The deficit between passenger revenues and the cost of owning and operating transit systems has gotten larger since the federal government first became involved (see Table 2 and Figure 3). By 2001, the aggregate annual loss for all public transit systems combined was more than

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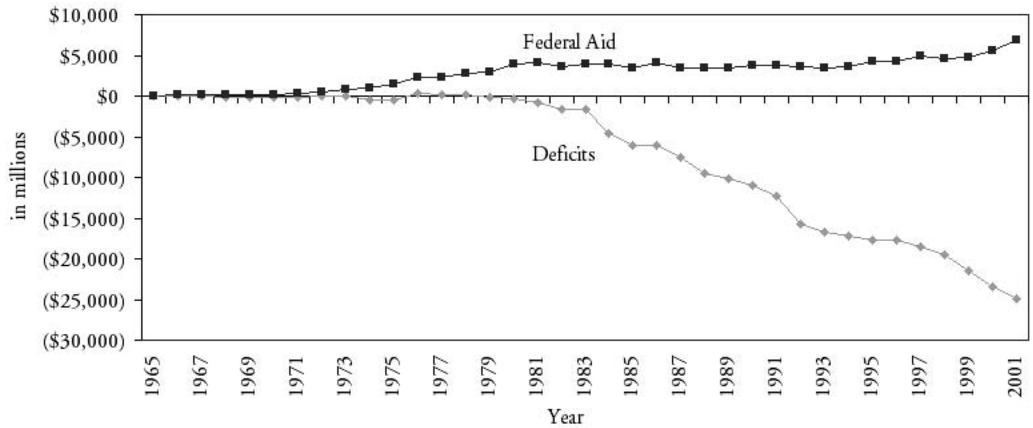
Table 2. Transit Financial Performance Since 1965 ($ in millions)

				Federal Aid		
Year	Revenue	Costs[b]	Net	Operating	Capital	Total
1965	1,340	1,454	(114)		51	51
1970	1,639	1,996	(357)		133	133
1975	1,860	3,752	(1,892)	142	1,287	1,429
1980	2,557	6,711	(4,154)	1,094	2,791	3,885
1985	4,575	14,077	(9,502)	940	2,510	3,450
1990	5,891	20,678	(14,787)	970	2,380	3,350
1995	6,801	25,079	(18,278)	817	5,481	6,298
2000	8,746	37,781	(29,035)	$994	4,526	5,520
2001	8,891	40,697	(31,806)	$1,130	5,769	6,898
Totals[a]	154,639	526,326	(371,687)	22,960	82,641	105,601

Source: *Public Transportation Fact Book* (Washington: American Public Transit Association, various years).
Notes: [a]Includes intervening years not shown above. [b]Operating expenses by functional class plus capital expense by type.

Figure 3. Federal Aid and Transit Deficits



Source: *Public Transportation Fact Book* (American Public Transportation Association, various years).

One consequence of the worsening financial performance of public transit is that taxpayers fund increasingly ineffective services at increasingly higher costs. The cost per passenger trip on transit has risen from around 18 cents in 1965 to more than four dollars by 2001.

$31 billion dollars (about $100 per capita). The cumulative loss over the whole period from 1965 through 2001 was in excess of $370 billion (about $1300 per capita).[14]

Federal subsidies of local transit have come attached to rules that have increased the cost of running these systems. On the one hand, Section 13(c) of the Urban Mass Transportation Act obstructs labor cost savings in federally subsidized transit by prohibiting changes in working conditions that would result in worsening the position of any employee. For example, federally subsidized transit systems may not attempt to save money by replacing eight-hour-day employees with part-time workers. The rules also prohibit federally subsidized transit systems from substituting split shifts for straight eight-hour shifts.[15] Compounding this, the Davis-Bacon Act raises the cost of transit construction by prohibiting competitive bidding on labor costs for federally aided projects. Under Davis-Bacon, the federal government requires all bidders on a federally assisted bus terminal or rail station construction project to pay the "prevailing wage" in the region where the work takes place. Transportation economist Gabriel Roth estimates that Davis-Bacon rules make federally aided construction projects about 28 percent more costly than they would be otherwise.[16]

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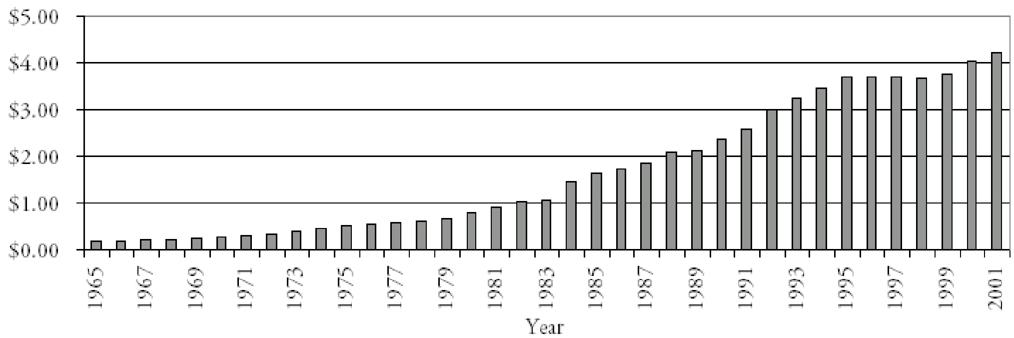
Figure 4. Transit Cost per Passenger Trip



Source: *Public Transportation Fact Book* (American Public Transportation Association, various years).

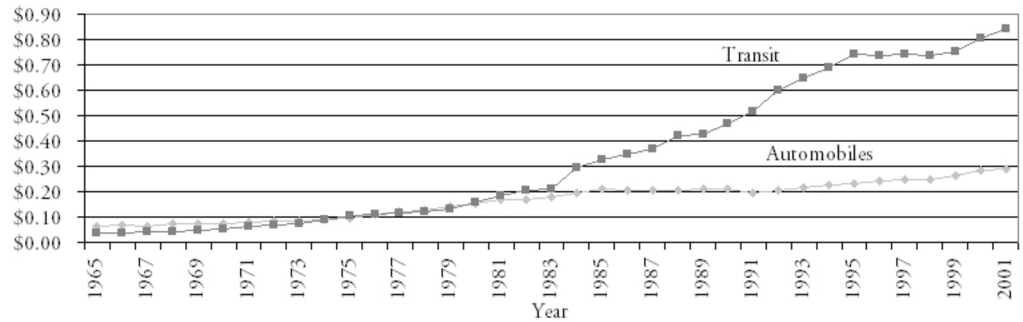
Public transit is so inefficient that it now costs more per passenger mile to travel on transit than it does to travel by car. Currently, the cost per passenger mile on transit is about 81 cents. The full cost of operating a car is about 29 cents per vehicle mile.

1965 to more than four dollars by 2001 (see Figure 4). Monetary inflation has raised the general price level by about 450 percent since 1965.[17] However, transit's per rider costs have risen by more than 2100 percent during the same period. The increase in transit costs has out-paced inflation, indicating that public transit has become increasingly inefficient in accomplishing the task of providing passenger transportation.

Before the federal government became involved in subsidizing public transit in 1965, riders paid 99 percent of the costs of their own transportation.[18] Since that time, transit expenses have ballooned out of control, and the only way public transit has been able to survive in its present form has been to force nonriders to bear increasingly larger shares of the cost.[19] As it now stands, transit fare box recovery ratios (the percentage of operating costs covered by passenger fares) average about 30 percent.[20] That means that if we exclude the costs of buying buses and trains and building tracks, stations, and stops, transit riders are paying about 30 percent of the cost of their rides. Taxpayers are compelled to pay the remaining 70 percent of operating costs. When we consider the total cost of providing public transit, riders' share of the cost drops to around 23 percent.[21] Nonriders are paying 77 cents of every dollar spent on public transit. Put another way, nonriders pay over three times as much for public transit as riders do.

Public transit is so inefficient that it now costs more per passenger mile to travel on transit than it does to travel by car. By the mid 1980s, the cost per passenger mile for transit rides began to exceed the full cost of owning and operating a car. Currently, the cost per passenger mile on transit is about 81 cents.[22] The full cost of operating a car is about 29 cents per vehicle mile (see Figure 5).[23]

Figure 5. Cost Per Passenger Mile for Transit and Per Vehicle Mile for Automobiles



Sources: http://americandreamcoalition.org/transportcosts.xls (October 20, 2003) and *Public Transportation Fact Book* (American Public Transportation Association, various years)

At income levels of $20,000 and above, driving alone is less expensive than taking transit.

Convenience and Competitiveness

Public transit is a time-intensive mode of travel. An American's average commute to work driving alone in his car is about 21 minutes. The average commute to work by public transit bus is about 38 minutes. The average commute to work by light rail or subway transit is about 45 minutes.[24] Time has value. The subsidies dispensed into public transit have been unable to bring transit travel times into a range competitive with driving one's own car. Consequently, the time-cost of using public transit makes it a relatively unattractive mode of travel for almost all except the very poor.[25]

If we include the time costs of commuting by various modes, it is clear why public transit's share of urban travel has been shrinking. Considering the full costs of operating a car, an individual's income level, and implicit value of time rise, and public transit becomes a more expensive mode of travel (see Table 3). At all income levels, carpooling offers a lower total cost of travel. At income levels of $20,000 and above, driving alone is less expensive than taking transit.

Table 3 tends to overstate the actual costs of using one's own car to commute. Unless taking transit means that one entirely gives up owning a car, a more relevant cost comparison would consider only the variable "out-of-pocket" costs of each auto commute trip. According to the American Automobile Association, that variable cost is about 12 cents per vehicle mile.[26] Using that as our frame of reference, we see that at almost all

Table 3. Time and Fare (Transit) or Operating (Auto) Cost of a Trip by Mode ($)[a]

Income level	Car[b]	Carpool[b]	Bus[c]	Rail[c]
10,000	5.24	3.64	4.09	4.66
20,000	7.00	6.03	7.25	8.41
30,000	8.76	8.41	10.42	12.15
40,000	10.51	10.80	13.58	15.89
50,000	12.27	13.18	16.75	19.64
75,000	16.67	19.14	24.66	29.00
100,000	21.06	25.11	32.57	38.35

Source: *Commuting in America II,* ENO Transportation Foundation, 1996, p. 85; and The American Dream Coalition, Bandon, Oregon, http://americandreamcoalition.org/transportcosts.xls.
Notes: [a]Auto cost/vehicle-mile = 29 cents; travel time in minutes: drive alone 21.1; three-person carpool 28.62.
[b]Transit fare per passenger = $0.92; travel time in minutes: bus 37.98; rail 44.92.

Because no amount of public money spent on transit systems is likely to have a significant impact on transit travel times, it is unlikely that transit will ever again serve more than a very small portion of total urban travel.

income levels, driving one's own car to work is a less costly mode of transportation. That would be the case even if transit charged no fares to its riders and the only cost to the rider were the time spent using the transit mode (see Table 4). Because no amount of public money spent on transit systems is likely to have a significant impact on transit travel times, it is unlikely that transit will ever again serve more than a very small portion of total urban travel.

Economic Impact

Proponents of continued or expanded tax expenditures on public transit have argued that transit spending is an "investment" that will revitalize a community:

- In 1984 the American Public Transit Association issued a report titled *National Impacts of Transit Capital and Operating Expenditures on Business Revenues,* asserting that for every dollar spent on rail transit, an additional $3.15 in revenues to other businesses was produced.
- In 1991 APTA issued another report, claiming that spending on transit had a long-term benefit/cost ratio of 3.29, meaning that every dollar spent on transit would generate $3.29 in long-term benefits. A press release accompanying the report asserted that a $100 billion "investment" in public transit would yield improved worker output valued at $521 billion over 10 years.[27]
- In 1997 the Campaign for Efficient Passenger Transportation published a report titled *Dollars and Sense: The Economic Case for Public Transportation in America,* arguing

Table 4. Time and Out-of-Pocket Operating Cost of a Trip by Mode[a]

Income level	Car[b]	Carpool[b]	Bus[c]	Rail[c]
10,000	3.20	2.91	3.17	3.74
20,000	4.96	5.29	6.33	7.49
30,000	6.72	7.68	9.50	11.23
40,000	8.47	10.06	12.66	14.97
50,000	10.23	12.45	15.83	18.72
75,000	14.63	18.41	23.74	28.08
100,000	19.02	24.37	31.65	37.43

Source: *Commuting in America II*, ENO Transportation Foundation, 1996, p. 85; and The American Dream Coalition, Bandon, Oregon, http://americandreamcoalition.org/transportcosts.xls.
Note: [a]Auto "out-of-pocket" costs and transit fares = 0. [b]Auto cost/vehicle-mile = 29 cents; travel time in minutes: drive alone 21.1; 3 person carpool 28.62. [c]Transit fare per passenger = 92; travel time in minutes: bus 37.98; rail 44.92.

that public transit "pays a handsome return on investment to the taxpayer, to the business community, to the transit user, and even to the motorist who never uses transit."[28]

- A 1999 report from the National Business Coalition for Rapid Transit asserted that every billion dollars invested in public transit capital projects generated 30,000 jobs, and the same amount invested in transit operations generated 60,000 jobs. The report suggested that the return on investment could be as high as nine to one.[29]
- A 1999 study by Cambridge Systematics claimed that in the year following the transit capital investment, 314 jobs are created for each $10 million invested. It also claimed that transit operations spending provides 570 jobs for each $10 million invested in the short run, and that businesses would realize a gain in sales of three times the public sector investment in transit capital and operations spending.[30]

If such returns were actually realized, the case for spending more money on transit would be strong. But a close examination of the evidence reveals that those claims are misleading.

First, the claims are based on correlations of transit expenditures and historical growth in the economy. Correlation, of course, does not prove causation; it merely demonstrates that two things seem to be happening simultaneously. The simultaneous growth of transit spending and the U.S. economy is more accurately explained by inverting the presumed cause and effect. That is, rather than the growth of transit outlays explaining the growth in the economy, it is the growth in the economy that explains the growth in transit outlays. With trains and buses carrying a dwindling share of urban travelers in the post-war U.S. economy, a more likely hypothesis is that the robust economic growth over the last 50 years has provided the means for both federal and local governments to indulge in transit spending. Growth of income, sales, and property values during this timeframe provided the tax revenue with which to subsidize public transit ventures.

Second, these claims fail to account for the alternative uses of economic resources, what economists call "opportunity costs."[31] Taking the 35 years of investment in public transit of federal tax dollars as a starting point, public transit spending since 1965 can be credited with assets and returns that currently support about one million jobs.[32] That sounds pretty good until it is compared with the outcomes that might have been achieved if the funds poured into money-losing public transit had been used in other ways. Since public transit has consistently had a negative return on investment, the assets acquired with the funds put into it have been largely consumed. As a result, the $370 billion in taxpayer money invested in public transit has a current estimated residual value of only $19 billion. If the $370 billion had been spent on "break-even" investments, the assets would have been conserved and the economy could theoretically have supported 10 million more jobs than it currently does. If the $370 billion had been directed to an investment yielding only a five percent return, the assets would have grown and the economy could theoretically have supported 32 million more jobs than it currently does. The outcomes of those alternatives are shown in Table 5.

Analyses like these are back-of-the-envelope estimates. Everything except the test variable – in this case, the way

The $370 billion in taxpayer money invested in public transit has a current estimated residual value of only $19 billion. If the $370 billion had been spent on "break-even" investments, the assets would have been conserved and the economy could theoretically have supported 10 million more jobs than it currently does.

Table 5 . Impacts on the U.S. Economy of Alternative Investments

	Amount invested ($ billions)	Current value of residual assets ($ billions)	Number of jobs (millions)
Public Transit	370	19	1
Break-even	370	370	19
5% return on investment	370	615	32

Source: American Public Transit Association, *2002 Public Transportation Fact Book* (various years).

Table 6 . 2000 Light Rail Performance Statistics

	Financial data ($ millions)					Passenger travel			
City	Passenger revenue[a]	Total outlays	Net profit (loss)	Passenger share (%)	Cost/passenger ($)	(millions) Miles	(millions) Trips	Miles/ Trip	% of travel
Baltimore	9.5	55.4	(45.8)	17	6.52	59.2	8.5	7.0	0.3
Boston	23.6	147.3	(123.8)	16	2.00	157.9	73.5	2.1	0.7
Buffalo	3.9	16.2	(12.3)	24	2.47	15.4	6.6	2.4	0.2
Cleveland	3.7	26.1	(22.4)	14	6.04	24.9	4.3	5.8	0.2
Dallas	7.2	296.1	(288.9)	2	25.90	60.2	11.4	5.3	0.1
Denver	3.5	61.9	(58.4)	6	9.27	28.2	6.7	4.2	0.2
Los Angeles	31.4	64.1	(32.7)	49	2.15	208.8	29.9	7.0	0.2
New Orleans	3.3	7.4	(4.1)	44	1.38	13.2	5.4	2.5	0.2
Philadelphia	13.0	53.5	(40.5)	24	2.14	61.5	25.0	2.5	0.2
Pittsburgh	6.0	65.2	(59.3)	9	8.87	33.2	7.4	4.5	0.2
Portland	18.5	152.9	(134.3)	12	6.27	140.9	24.4	5.8	1.2
Sacramento	7.1	74.4	(67.3)	10	8.62	45.9	8.6	5.3	0.4
Salt Lake City	5.5	51.0	(45.5)	11	8.31	49.7	6.1	8.1	0.7
San Diego	20.9	66.9	(46.0)	31	2.33	188.3	28.7	6.6	0.8
San Francisco	25.0	186.3	(161.2)	13	4.48	108.8	41.6	2.6	0.3
San Jose	5.6	155.9	(150.3)	4	19.70	35.8	7.9	4.5	0.3
St. Louis	12.2	124.1	(111.9)	10	8.76	95.3	14.2	6.7	0.4
Totals	200.0	1,604.7	(1,404.7)	12	5.17	1327.2	310.2	4.3	0.3

Sources: Federal Transit Administration, *Transit Profiles for the 2000 National Transit Database Report Year,* Washington, DC; and Federal Highway Administration, *Highway Statistics 2000*, Washington, DC.
[a]Revenues allocated to mode based on share of passenger miles.

When opportunity costs are taken into account, there can be no question that putting money into public transit lowers the rate of economic growth, consumes capital, reduces job opportunities, and worsens the finances of federal and local governments.

$370 billion could have been invested – was held constant. In the real world, everything cannot be held constant. The important point of this exercise is to see the relative magnitudes of the impacts of each alternative. Given the weak financial performance of public transit over 35 years, it is likely that the country would have been considerably better off if the $370 billion in taxes had not been spent on public transit. When opportunity costs are taken into account, there can be no question that putting money into public transit lowers the rate of economic growth, consumes capital, reduces job opportunities, and worsens the finances of federal and local governments. Moreover, if multipliers are attached to dollars spent on transit, then they must also be used to calculate the cost of those dollars that can no longer be spent on alternatives.

Light Rail: A Nationwide Assessment

Construction of light rail (streetcar and interurban) systems had largely ceased in America prior to the conclusion of World War II, but interest resurfaced in the 1980s. Since then, several cities have embarked on building light rail systems. Systems in San Diego and Portland have partially fueled the interest in a light rail system for the Phoenix area. But the performance of light rail in San Diego, Portland, and other cities suggests that light rail is underused, inefficient, and inequitable.

American cities with light rail transit collectively spend more than $2 billion per year on capital and operating expenses. In the aggregate, this amounts to more than six dollars per passenger trip. Since the average passenger trip is approximately four miles, the cost per passenger mile is around $1.48.[33] That cost compares unfavorably with the costs of other modes of transportation. The average cost per bus passenger mile is about 78 cents.[34] The average cost per vehicle mile of automobile transportation is around 29 cents.[35]

Light rail's inefficiency is not offset by effectiveness. Light rail is supposed to reduce urban traffic congestion by luring drivers out of their cars. But the low ridership actually attained by light rail transit systems overstates their impact on traffic congestion and air pollution. New rail lines are typically constructed along routes where bus ridership is already heavy. In the interest of achieving the best possible ridership results, that selection of routes makes sense. However, it also means that a significant portion of rail transit riders are former bus riders. In Los Angeles, it is estimated that only 10 to 15 percent of the riders on newly constructed rail lines are former automobile drivers. The remaining 85 to 90 percent are former bus riders.[36] This phenomenon is not unique to Los Angeles but is common to all new rail lines.[37] Consequently, the actual impact of introducing new rail transit service into a community is far smaller than it might appear from both ridership forecasts and actual passenger trips involving the rail line. Even counting former bus passengers, light rail carries less than three-tenths of one percent of the person-miles of travel in the cities where it operates. Of all the options in the current public transit mix, light rail is the least effective choice (see Table 6).

A significant portion of rail transit riders are former bus riders. In Los Angeles, it is estimated that only 10 to 15 percent of the riders on newly constructed rail lines are former automobile drivers. Even counting former bus passengers, light rail carries less than three-tenths of one percent of the person-miles of travel in the cities where it operates.

Equity Issues

Public transit advocates have sometimes claimed that inequitable public policies favoring the automobile are the primary culprit behind the poor record of public transit.[38] In absolute dollar terms, the amount of public sector expenditures on roads is substantially larger than that for public transit. For 2001, government at all levels spent nearly $130 billion on roads[39] and about $40 billion on public transit.[40] Public sector spending on roads is more than three times as large as public sector spending on transit.

While the ratio of spending may be

Table 7. External Costs and Subsidies for Different Passenger-transport Modes (cents per vehicle mile, except last row is cents per passenger mile) [Numbers in brackets are best estimates]

Cost Item	Gasoline Auto	Electric Auto	Transit Bus	Light Rail	Heavy Rail
Air pollution	0.8 to 13 [2.0]	1.5	5.4 to 123 [20.0]	5*	5*
Oil use, water pollution	0.3 to 1.5 [0.8]	0.4	1.5 to 8.7 [4.0]	1*	1*
Noise	0.01 to 2.0 [0.2]	0.15	0.5 to 10.0 [2.0]	1*	1*
Congestion	4.0	4.0	8.0	not estimated	not estimated
Accidents	2.5	2.6	3.5	2*	2*
Marginal highway and service costs	0.1	0.1	1.5	0	0
Unpriced parking	0 to 8 [0]	0 to 8 [0]	0	0	0
Inefficient highway user taxes and fees meant to cover highway costs	-2.7	0	0 (exempt from fuel taxes)	0	0
Government subsidy:					
Operating costs minus fares	0	0	339	685	372
Operating + rolling-stock costs minus fares	0	0	[398]	1,137	797
Total operating + capital costs minus fares**	0	0	465	2,800	1,177
Extra private costs relative to gas auto	0	0 to 16 [8]	see subsidy	see subsidy	see subsidy
Total cents per vehicle-mile	assume 1.0	assume 1.0	10.9 (avg.)	25.7 (avg.)	22.3 (avg.)
Total cents per passenger mile	5 to 28.4 [6.9]	8.8 to 24.8 [16.8]	33 to 57 [40]	27 to 109	17 to 53

Source: Mark Delucci, "Should We Try to Get the Prices Right?" *Access* 16 (Spring 2000): 12

*Data are not available for these numbers, which are estimated based on studied judgment.

**Note that, because the official statistics do not report passenger fare payments by individual transit mode, it is not possible to calculate the actual government subsidy for each mode. Ratio of fare payments to operating expenses is assumed to be the same for all modes.

three to one in favor of roads, the use of roads is far higher. In 2001, there were more than four trillion person-miles of travel.[41] For the same year, there were 49 billion passenger-miles of travel on public transit.[42] Of government expenditures for roads and transit combined, transit receives about 23 percent of the outlays but provides barely 1.2 percent of the total person-miles of travel.

Another key equity issue is the source of government outlays. The beneficiaries of public transit pay only about 22 percent of the cost of their trips.[43] Highway users, on the other hand, pay about 65 percent of the amount governments spend on roads, and that does not include taxes levied on vehicle owners that are deposited in general funds at the state and local levels.[44] For example, the sales taxes paid for the purchase of autos and auto supplies go into state and local general funds. In addition, some states, including Arizona, levy taxes on the value of autos. Only a portion of those taxes goes into highway user funds, with the rest going into the general fund. When other taxes assessed on autos are considered, it appears that road users pay over 100 percent of the cost of roads.[45] Public transit systems are not burdened with similar taxes.

Some transit advocates claim that transit is more cost-effective on a total social cost basis.[46] Including costs imposed on the rest of society by automobiles and transit (costs such as traffic congestion and air pollution) diminishes the amount of subsidies to transit.[47] But an analysis of costs and subsidies by mode of travel in urban regions conducted by Mark Delucci (see Table 7) shows transit receiving greater subsidies than automobile transport when all costs are considered.[48]

Of government expenditures for roads and transit combined, transit receives about 23 percent of the outlays but provides barely 1.2 percent of the total person-miles of travel.

Environmental Impact

Is public transit good for the environment? Given the higher carrying

Table 8. Energy Efficiency by Mode

Mode	BTU/person-mile*	BTU/person-mile**
Automobile	3,598	4,096
Transit bus	3,415	4,143
Light rail	3,585	5,278

*David Shen and Jer-Wei Wu, *Commuter Rail: State-of-the-Art* (Washington, DC: Federal Transit Administration, December 1992).
**Wendell Cox et al., *The Livable American City: Toward an Environmentally Friendly Dream* (Washington, DC, American Legislative Exchange Council, August 1993).

Public transit is serving a smaller share of the population than it was 35 years ago. The credit for any improvements in air quality must go to improvements made in automobiles and the fuels they use.

capacity per bus or train, it would seem that transit could provide some environmental benefits. But because public transit's actual ridership falls far short of its theoretical carrying capacity, it is inappropriate to use carrying capacity for estimating environmental impact. The actual average load factor for transit in the year 2001 was 14 percent.[49] As a result, the energy efficiency of public transit does not seem to be any better than that of automobiles (see Table 8).

Objective measures show that urban air quality has been improving over the last two decades. In terms of ambient air pollutants, carbon monoxide has dropped by 67 percent since 1976, nitrous oxides have decreased by 38 percent, ozone has decreased by 28 percent, and particulates have decreased by 26 percent.[50] On a per-vehicle-mile-of-travel basis, automobiles emit 93 percent less hydrocarbons, 83 percent less nitrous oxides, and 89 percent less carbon monoxide than they did in 1967.[51]

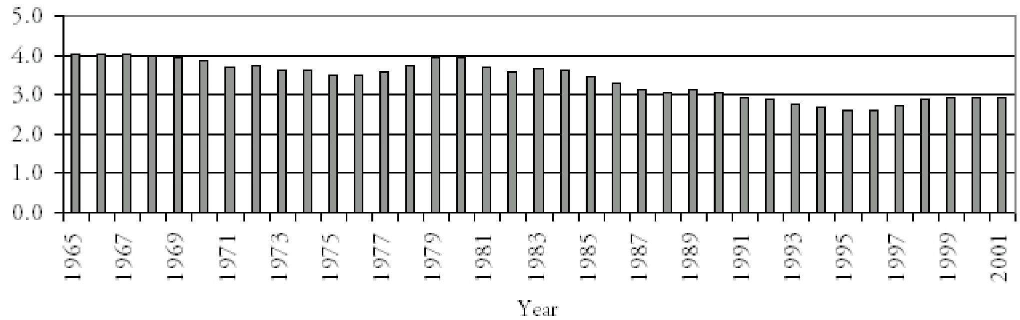
The improvements made in air quality over the last two decades owes little to public transit. Public transit ridership has increased by 18 percent since 1967.[52] During this same time period, the U.S. population has increased by about 44 percent.[53] Thus, public transit is serving a smaller share of the population than it was 35 years ago. The credit for any improvements in air quality must go to improvements made in automobiles and the fuels they use. With fleet turnover and existing employed technology, urban air should continue to improve despite an expected increase in vehicle-miles of travel.[54] And, new "cold start" emissions devices may reduce vehicle emissions by another 70 percent below the levels projected under existing technology.[55]

Expanding Service to Tap Latent Demand

Theoretically, transit ridership could increase if hours of operation or locations served could be expanded. In other words, it is theoretically possible that an unserved latent demand for public transit exists, even though current provision of transit in American cities is insufficient to provide suitable service to potential transit users.[56] In reality, however, actual expansions of transit service have been followed by decreasing passenger load factors.

Since 1965, the quantity of transit service has increased significantly. Bus-miles of service rose 60 percent, from 1500 million in 1965 to around 2400 million in 2001. Heavy rail vehicle-miles of service rose over 50 percent, from less than 400 million to more than 600 million. Light rail vehicle-miles of service rose from around 40 million in 1965 to around 54 million in 2001.[57] The total increase in transit carrying capacity was 55 percent over that time period. If adding more service were the key to improving the performance of public transit, we should have seen the number of passengers increase by a percentage larger than the percentage increase in vehicle-miles of service. But

Figure 6. Boardings per Vehicle-mile



Source: *Public Transportation Fact Book* (American Public Transportation Association, various years).

In 1965, there were 4.0 passengers per vehicle-mile. By 2001, the number of passengers per vehicle-mile had fallen to less than 3.0. Therefore, cities contemplating expanding public transit services should not do so under the expectation that the gain in riders will exceed the increase in quantity of service.

the actual increase in ridership was less than 20 percent, rising from 8.3 billion passenger journeys in 1965 to 9.6 billion passenger journeys in 2001.[58] The theory that adding more public transit service would stimulate demand has not been borne out by experience.

Indeed, the evidence from 1965 to 2001 supports a contrary theory: the public transit that already exists is serving the highest demand segments of its potential market, and expansion of service to other times and locations will be aimed at market segments with lower inherent demand for transit. Consequently, we can hypothesize that the number of passengers per vehicle-mile will decline as transit service is expanded. This is, in fact, what has happened. As shown in Figure 6, in 1965, there were 4.0 passengers per vehicle-mile. By 2001, the number of passengers per vehicle-mile had fallen to less than 3.0.[59] Therefore, cities contemplating expanding public transit services should not do so under the expectation that the gain in riders will exceed the increase in quantity of service. Instead, transit expansions will more likely produce dwindling load factors, more empty seats per mile, and increasing costs per passenger served.

Transit Safety

Automobile travel is inherently risky, but it appears that introducing more transit vehicles into the mix of traffic will increase those risks. A recently published study of light rail transit crashes for a sample of cities indicates that light rail trains are dangerous additions to urban traffic streams.[60] The statistics, based on data as of 1996, show that with only one exception, crashes per vehicle-mile of travel were far higher for light rail transit than they were for motor vehicles. Data for the nine light rail systems in U.S. cities featured in the

Table 9. Crashes per 100 Million Vehicle-miles of Travel

Light rail transit system	Rate
Baltimore	1,351
Dallas	1,514
Denver	6,471
Los Angeles	1,222
Portland	1,356
Sacramento	1,144
St. Louis*	20
San Diego	676
San Jose	1,349
Average	1,125
U.S. highway system	276

Note: Crash rates are calculated using crash data from Table S-2 and VMT data from Federal Transportation Association, *1996 Transit Profile* (Washington, DC, 1997). The highway data is obtained from Federal Highway Administration, *Highway Statistics 1996*; and National Highway Traffic Safety Administration, *1996 Traffic Crashes, Injuries, and Fatalities* (Washington, DC, 1997).
*The St. Louis figure may be low due to its grade-separated right of way (atypical for light rail).

The statistics show that with only one exception, crashes per vehicle mile of travel were far higher for light rail transit than they were for motor vehicles. Data for the nine light rail systems in U.S. cities showed an average crash rate of 1,125 per 100 million vehicle miles of travel, four times higher than the 276 crashes per 100 million vehicle miles for motor vehicles.

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Factors leading to crashes that were cited in *Light Rail Service: Pedestrian and Vehicular Safety TCRP Report 69*[61] include:

- Motorists drive around lowered gates.
- Motorists disregard regulatory signs at light rail crossings.
- Motor vehicles often block the light rail tracks.
- Motorists are confused when both light rail and traffic signals are used at the same location.
- Motorists become confused about gates rising and lowering.
- Pedestrians dart across light rail tracks without looking both ways.
- Pedestrians ignore warning signs.
- Pedestrians trespass along the light rail right-of-way.
- Pedestrians do not cross the track at designated locations.
- Crossing users and light rail vehicle operators are unable to see each other.
- Automatic gates descend behind stopped motorists, trapping them on the tracks.

Table 10. Urban Travel Fatality Rates by Mode for 2001

	Bus	Commuter rail	Heavy rail	Light rail	Urban auto
Vehicle-mile Rate*	50	315	42	307	10
Passenger-mile Rate**	5	8	2	11	9

Sources: American Public Transportation Association, *2003 Public Transportation Fact Book* (Washington, DC, 2003), Tables 6, 18, 40; and Federal Highway Administration, *Highway Statistics 2001* (Washington, DC, 2003), Tables VM-1, FI-10.
*Fatalities per billion vehicle miles.
**Fatalities per billion passenger miles.

- Light rail vehicle operators are unable to confirm that flashing light signals and automatic gates are functioning properly.

Motorist and pedestrian lack of familiarity with light rail transit may be a significant factor leading to crashes. Metropolitan regions embarking on ventures into light rail transit must give safety issues a place on the planning agenda. That said, crashes involving transit vehicles generally entail little risk for light rail passengers, and travel as a passenger on public transportation is far safer than travel by private car. The fatality risk for a person traveling in a car is almost 20 times higher than that for a person traveling in a bus.[62] The large size and weight of buses make their occupants more likely to survive collisions with smaller, lighter vehicles. Passengers traveling in rail transit vehicles, which are even larger and heavier than buses, probably face a similarly low risk.

Unfortunately, the on-board risk is not the only safety issue of concern. Riders face risks prior to boarding transit vehicles, and rail transit vehicles operating on rights-of-way that intersect streets – as is the case for most light rail systems – may collide with persons, vehicles, or objects that come into the path of the transit trains. As a result, light rail has severe safety deficiencies when compared to other modes of urban travel. The aggregate fatality rate for auto travel is around 15 persons per billion vehicle miles of travel. However, that includes rural travel, where the fatality rate per billion vehicle miles is 23. The nationwide fatality rate per billion vehicle miles of urban automobile travel for the year 2001 was 9. Thus, light rail's rate of 11 fatalities per billion passenger miles of travel was actually higher than the rate for privately operated automobiles.[63]

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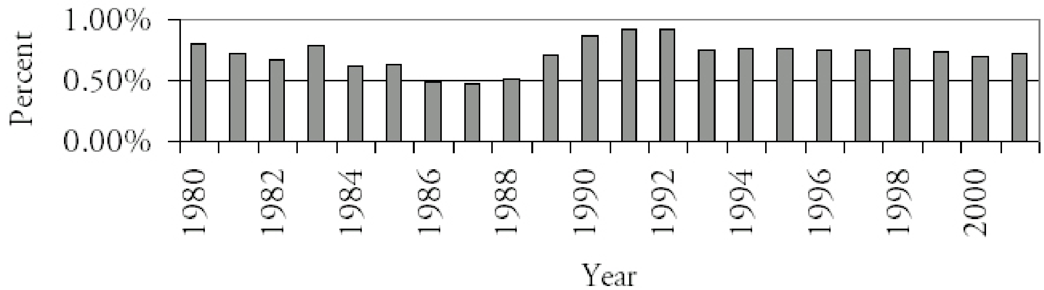
Because light rail trains are usually operated in streets, the more relevant fatality statistic for automobile drivers and pedestrians to consider is the per-vehicle-mile fatality rate. Light rail's

Figure 7. Transit's Share of Travel in Phoenix Region



Source: *Annual Transit Reports* (Valley Metro, various years) and *Highway Statistics* (FHWA)

Transit's share of travel in the Phoenix metropolitan region is not growing. Data from the last 20 years indicate that transit's share has never reached one percent of total travel.

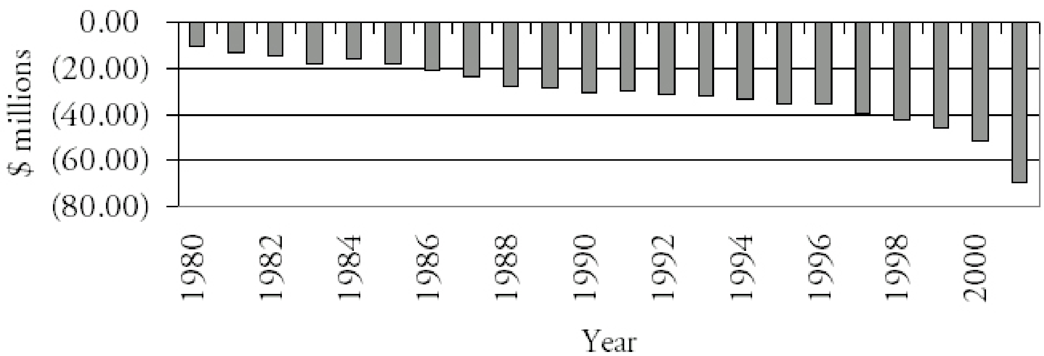
fatality rate of 307 per billion vehicle miles of travel makes light rail no safer than any other mode. In fact, the non-occupant fatality rate for light rail is more than 10 times greater than that for heavy trucks.[64] And even that underestimates the hazards of light rail systems built into city street medians. Persons darting into traffic in an attempt to reach a light rail train before it leaves and who are hit by cars or trucks are not counted in the transit crash statistics. Yet, those accidents and fatalities would not occur without the existence of light rail transit stations in the middle of streets.

Transit in Maricopa County

Transit's Share of Local Travel

Although long-term statistics are not as readily available for the Phoenix transit system as they are for the nation as a whole, it is clear that transit's share of travel in the Phoenix metropolitan region is not growing. Data from the last 20 years indicate that transit's share has never reached one percent of total travel. It has fluctuated between 5/10ths and 9/10ths of one percent for that entire period (see Figure 7). The combination of rising family income and the relative inconvenience of transit for most trips work against the system's achieving a growing share of total travel.

Figure 8. Phoenix Transit Operating Deficits



Source: Annual Transit Reports (Valley Metro, various years)

Fiscal Impact

The Phoenix transit system has consistently lost money, and its deficits rose by nearly 600 percent from 1980 to 2000 (Figure 8). The cumulative loss on an operating basis for the 20-year period was in excess of $600 million.[65] It should be noted that the operating statements produced by Valley Metro (previously Phoenix Transit) exclude capital costs – meaning the costs of buying buses, building facilities, and borrowing money to finance those items are not incorporated. To be sure, the goals of a government service rarely include operating profitably, so operating deficits do not necessarily imply that the service in question should not be provided. The main concern is whether the benefits of a service merit the costs, and it is with that in mind that data on the growing costs of the Phoenix transit system are included.

MAG's Planned Transit Expansion

Valley Metro is in the initial stages of implementing a 20-mile light rail system at an estimated cost of approximately $50 million per mile.[66] The document submitted in support of Valley Metro's application for federal transit aid to the proposed light rail system provides estimates of the traffic and environmental impacts of the proposed transit system.[67]

The capital cost of the 20-mile light rail system is projected at about $1.0 billion. The projected cost per passenger boarding is over $12.[68] The fare revenue per passenger boarding is projected to be less than 70 cents.[69] The share of the costs paid by riders is projected at five percent for light rail, with taxpayers

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Table 11. Cost Per Person-Mile of Travel Under MAG Plan ($)

	Sales tax	Other taxes	Private costs/fares	Total
		Phoenix Region Data		
Freeways	0.03	0.03	0.29	0.35
Arterial Streets	0.03	0.02	0.29	0.34
Buses	0.47	1.12	0.28	1.87
Light Rail	1.18	1.57	0.15	2.90
		National Data		
Roads	N/A	0.05	0.29	0.34
Buses	N/A	0.58	0.20	0.78
Light Rail	N/A	1.34	0.14	1.48

Sources: Valley Metro, *Regional Transportation Plan* (MAG), *Central Phoenix/East Valley Light Rail Project*; The American Dream Coalition, http://americandream coalition.org/transportcosts.xls; Federal Highway Administration, *2001 Highway Statistics* (Washington, DC, 2003), Tables HF-10, VM-1; and American Public Transportation Association, *2003 Public Transportation Fact Book* (Washington, DC, 2003), Tables 6, 48, 61, 64.

The average cost to the taxpayer for providing a person-mile of service is around six cents for freeways and five cents for arterial streets. That is considerably less than the $1.59 cost per person-mile for buses and the $2.75 cost per person-mile for light rail.

paying the other 95 percent.[70]

Valley Metro is also proposing a 30-plus mile expansion of the light rail system. That proposed expansion is part of the Maricopa Association of Governments Transportation Plan that will require approval by the state legislature and voter approval by ballot, likely in May.[71] The plan calls for a half-cent sales tax for 20 years to fund a combination of roadway and transit outlays.

One way to evaluate alternative uses of investment funds is to compare returns on investment. When faced with different types of investment options – freeways vs. light rail, for example – a common denominator is needed. Since the main objective of the Maricopa Association of Governments' plan is to provide transportation for people, the obvious common denominator is person-miles of travel, or the cost to transport one person one mile using the various alternatives. Table 11 is based on data from MAG and Valley Metro. Costs include both capital and operating expenses over a 20-year period. Ridership for transit and vehicle miles of travel for automobiles are projected over the same 20-year period. Costs are further broken out into those financed through taxes and those financed through payments made by users (fares in the case of transit riders, vehicle ownership and operating costs for automobile drivers).

The cost of providing transportation is significantly lower if roads are built than if transit systems are constructed and operated. The average cost to the taxpayer for providing a person-mile of service is around six cents for freeways and five cents for arterial streets.[72] That is considerably less than the $1.59 cost per person-mile for buses and the $2.75 cost per person-mile for light rail.[73] In terms of the proposed sales taxes to be invested, the average cost of providing a person-mile of service is around three cents for both freeways and arterial streets. That is considerably less than the 47-cent cost per person-mile for buses and the $1.18 cost per person-mile for light rail.

Since the government provides large subsidies to transit users, a person who rides the bus is projected to pay about 28 cents per person-mile of travel, and a light rail rider is projected to pay only 15 cents per person-mile. Meanwhile, the cost of owning and operating an automobile averages about 29 cents per vehicle mile.[74] So, from a personal cash-expense standpoint, it is less costly for an individual to use transit than to own and operate a car. That more people do not use transit is probably a result of its inconvenience. Average travel speeds for buses in the Phoenix metropolitan region are in the 14 mph range. The advertised travel speed for the light rail is in the 20 mph range,[75] although the national average speed for light rail is 15.1 miles per hour.[76] Those speeds do not include waiting times or the time it takes to get from one's home to the bus stop or train station.

When all costs are considered, the highway-automobile combination is the least expensive option. The highway-automobile combination costs around 32 cents per person-mile of travel. At $1.87 per person-mile, bus transit is five times as costly. At $2.90 per person-mile, light rail transit is more than eight times as expensive. In terms of obtaining the most benefit at the least total cost to society, the highway-automobile combination is the best investment.[77]

Of course, not all highway investments cost the same. For example, the proposed double-decking of I-17 would cost about twice as much in taxes per person-mile as the rest of the county's proposed roadways.[78] Nevertheless, even the least efficient roadway investment is far less costly than transit for providing person-miles of transportation. And that does not include the substantial benefits of freight movement that roads provide.

Valley Metro's estimated cost per passenger trip for light rail is $12.39. That means that it will cost $24.78 per passenger, per day for a round trip commute to work on light rail, and more if bus connections are included. That adds up to nearly $6,000 per passenger per year in a typical work year. Of that total, the passenger would only pay about $300, with taxpayers paying the other $5,600.

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Because the regional share of travel for all transit modes is about one percent of total person-miles of travel, spending 30 percent of the regional tax revenue on transit appears inequitable. Under the

Table 12. Projected Transit Performance, Light Rail vs. Bus Rapid Transit

	Light Rail Transit		Bus Rapid Transit		BRT savings/
Route	Annual cost ($ millions)	Cost/ boarding	Annual cost ($ millions)	Cost/ boarding	boarding vs. LRT
59th Ave	70	14.85	40	8.55	6.30
Bell Road	11	15.36	66	9.11	6.25
Camelback	36	12.00	21	7.04	4.96
Chandler Blvd.	64	14.44	34	7.67	6.77
Main St	39	10.98	29	8.06	2.92
Power Road	45	14.40	39	12.30	2.10
Scottsdale Rd/ Tempe	102	13.49	27	3.61	9.88
SR-51	80	17.82	58	12.93	4.89
UP Chandler	47	10.34	35	7.59	2.75
Totals/Averages	737	13.25	348	8.17	5.08

Source: Maricopa Association of Governments, *High Capacity Transit Study*, 2003, Tables 9-3 and 9-4, pp. 78 and 80, http://www.mag.maricopa.gov/pdf/cms.resource/HCT-Final-Report.pdf.

Mile for mile, the Piestewa Freeway serves more than 20 times more travel demand than a light rail line placed in an optimal corridor. Whether the perspective is regional or corridor-by-corridor, light rail is clearly an inferior option when it comes to serving the travel needs of the Phoenix metropolitan region.

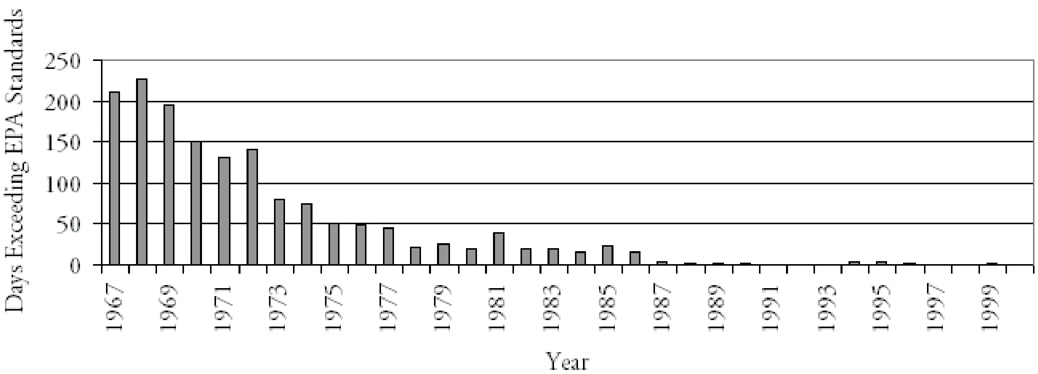
MAG Transportation Plan, for every dollar spent to benefit automobile drivers, $40 would be spent to benefit transit riders.[79] In other words, the plan would spend 40 times as much for the benefit of transit riders as it would spend for the 99 percent of the population that travels by car.

To put light rail's prospective impact on traffic into perspective, compare it to the impact on traffic of a freeway facility such as the Piestewa Freeway. The Piestewa Freeway averages 130,000 vehicles per mile per day.[80] The prospective light rail line would average little more than 6,000 passengers per mile per day between its opening in 2006 and year 2020.[81] Mile for mile, the Piestewa Freeway serves more than 20 times more travel demand than a light rail line placed in an optimal corridor. Whether the perspective is regional or corridor-by-corridor, light rail is clearly an inferior option when it comes to serving the travel needs of the Phoenix metropolitan region.

Light Rail vs. Bus Rapid Transit

In terms of the cost per person served, light rail is the least cost-effective alternative that could have been chosen. Valley Metro projects that light rail would cost over $12 per passenger boarding, while bus service would cost $7 per passenger boarding.[82] MAG went a step further and calculated the comparative cost of providing service in selected corridors by light rail transit versus bus rapid transit. Bus rapid transit service is characterized by few stops and

Figure 9. Carbon Monoxide Pollution in Central Phoenix



Source: Maricopa County Environmental Services, http://www.maricopa.gov/envsvc /AIR/AIRDAY/co-hdata.asp.

Air quality in Phoenix has improved over the last 30 years, although transit's contributions have been exceedingly small.

long routes. Typically, passengers would board at a few locations clustered in a suburban community and then travel nonstop to downtown Phoenix to be dropped off at a few locations in the center of the city. As shown in Table 12, bus rapid transit would be less expensive than light rail transit on every route.[83]

Equity Issues

Spending on roads in the Phoenix metropolitan region averages around $700 million per year,[84] whereas spending on Phoenix transit has been only a fifth of this amount.[85] So in absolute numbers, it appears transit has been short-changed; but the reality is that transit provides less than one percent of passenger transportation in Phoenix. Furthermore, although Phoenix freeways are the main beneficiaries of a subsidy from a county sales tax, that subsidy from non-users is offset by the 60 percent of the vehicle license tax used to subsidize nonhighway government spending.[86] The net result is that road users in Arizona pay taxes sufficient to cover the full cost of their use of the roads.[87] By contrast, transit users pay only about 20 percent of the cost of the Phoenix bus service.[88] And transit users are projected to pay 15 percent for bus rides and five percent for light rail rides under any expansion of the current system.[89]

Environmental Impact

Air quality in Phoenix has improved over the last 30 years (see Figure 9), although transit's contributions have been exceedingly small. In 1970 there were 150 days on which the air in central Phoenix exceeded the Environmental Protection Agency's carbon monoxide standards, but in 2000 there were no days on which those same standards were violated.[90] During those 30 years of air quality improvement, *In a report prepared for the Arizona Department of Transportation, transit ranked near the bottom of the list in terms of cost-effectiveness in reducing air pollution. Rail transit ranked dead last, costing hundreds of thousands of dollars per ton of pollution reduction.*

transit – which makes up less than one percent of urban travel – has had a minimal impact. The main factor in Phoenix, as elsewhere, has been improvements in automobile and fuel technology.[91]

Future improvements in Phoenix air quality will also have to come from some source other than expanded public transit. In 1996, two studies evaluated the probable air quality impacts of various transportation options. In terms of both magnitude of impact and cost-effectiveness, transit fared poorly when compared to other alternatives. In a report prepared for the Arizona Department of Transportation, transit ranked near the bottom of the list in terms of cost-effectiveness in reducing air pollution. Rail transit ranked dead last, costing hundreds of thousands of dollars per ton of pollution reduction.[92] The magnitude of the impacts for other transit measures was also small. The impact of transit on air pollution is projected to be less than one percent.

Transit also compared unfavorably in the *Alternative Transportation System Task Force Report to Governor Fife Symington*.[93] The core finding was that the Phoenix metropolitan region could achieve a substantial improvement in air quality at a very low cost from a program that targets high-emitting vehicles. The expected pollution reduction from measures targeting high-emitting vehicles is 35,598 tons per year, or 65 percent of the total projected impact of all the recommended options. The combined cost of all four high-emitter options is $5 million per year, or about seven percent of the total cost to state and local governments of the package of recommendations. In contrast, the projected pollution reduction from bus expansion – 900 tons per year – is less than two percent of the total projected impact.[94]

Table 13 combines the data from the two reports. The inescapable conclusion is that investments in public transit have a poor cost-benefit ratio if the goal is pollution reduction.

Valley Metro's Environmental Impact Statement

In November 2002, Valley Metro filed an environmental impact statement to accompany its application for federal aid for light rail.[95] The statement disclosed that building light rail tracks in Phoenix-area streets may actually increase traffic congestion and air pollution.

With regard to traffic congestion, building the light rail system is expected to reduce vehicle miles of travel by about 0.04 percent in the region and 0.13 percent in the corridor served by the light rail system.[96] That amounts to taking one car out of 2,500 from the traffic stream in the region and about one car in 750 from the traffic stream in the corridor. But rather than resulting in a tiny improvement in traffic congestion, the increase in hours spent by vehicles in the traffic stream reveals that congestion may actually increase. Vehicles hours of travel are expected to

Table 13. Traffic Reduction Measures Ranked by Cost-Effectiveness

			Traffic		Air Quality	
Option	Timing of Impact	Additional Cost/Year ($ millions)	Traffic Impact (%)	Cost/1% ($ millions)	Pollution Reduction (tons/yr.)	Cost/ Ton ($)
Proximate commuting	near term	0	3.0	0	11,000	0
Compressed work week	near term	0	1.4	0	5,000	0
Jitneys	near term	0	0.5	0	1,900	0
Flextime	near term	0	0.3	0	1,000	0
Privatize buses	near term	0	0.2	0	750	0
Guaranteed ride home	near term	0.4	0.4	1.0	1,500	270
Telecommuting	near term	3.4	2.0	1.7	7,500	450
HOV to HOT lanes	near term	4.0	2.0	2.0	7,500	530
Synchronize signals	near term	16.0	8.0	2.0	30,000	530
Congestion pricing	near term	20.0	10.0	2.0	37,000	540
Freeway management	near term	17.0	2.0	8.5	7,500	2,300
Complete freeways	long term	100.0	8.0	12.5	30,000	3,300
Bus expansion	near term	138.0	0.8	172.5	3,000	46,000
Light rail	long term	57.0	0.2	285.0	750	76,000
	Air Quality Measures Ranked by Cost-Effectiveness					
Super Emitter Measures	near term	8.4	N/A	N/A	36,000	230
Mobile Emissions	near term	23.0	N/A	N/A	90,000	260

Sources: Matthew Rowell et al., *The Cost Effectiveness and Magnitude of Potential Impact of Various Congestion Management Measures* (Phoenix: Arizona Department of Transportation, March 1997) and *Alternative Transportation System Task Force Report to Governor Fife Symington*, Phoenix, November 15, 1996.

In November 2002, Valley Metro filed an environmental impact statement to accompany its application for federal aid for light rail. The statement disclosed that building light rail tracks in Phoenix-area streets may actually increase traffic congestion and air pollution.

Table 14. Impact of Light Rail on Traffic Congestion

	No Build	Light Rail	Impact
		Daily Vehicle Miles of Travel	
Region	108,258,800	108,213,200	-0.04%
Corridor	18,278,600	18,254,400	-0.13%
		Daily Vehicle Hours of Travel	
Region	4,827,800	4,849,500	+0.45%
Corridor	1,018,700	1,031,200	+1.23%

Source: Valley Metro, *Central Phoenix/East Valley Light Rail Project: Final Environmental Impact Statement,* pp. S-18, S-8, S-9

Table 15. Carbon Monoxide Parts/Million

	Year 2020			
	Existing	No-build	Build	Build vs. no-build
		One-hour levels		
Bethany & 19 Ave.	7.5	6.0	6.9	+0.9
Camelback & 19 Ave.	7.8	6.2	7.3	+1.1
Van Buren/Grand/7 Ave.	6.9	6.1	6.4	+0.3
Indian School & 7 St.	8.7	7.4	7.3	-0.1
McDowell & 7 St.	8.7	7.7	7.5	-0.2
I-10 & 7 St.	5.7	4.8	4.8	0.0
Washington & 32 St.	5.7	5.1	5.4	+0.3
Apache Blvd & Rural	8.6	6.9	7.7	+0.8
Apache Blvd & McClintock	10.7	8.3	8.8	+0.5
Broadway & Dobson	10.0	9.9	7.8	-2.1
Broadway & Extension	6.1	5.4	5.7	+0.3
Apache Blvd & Price	4.9	4.2	5.5	+1.3
Average	7.6	6.5	6.8	+0.3
		Eight-hour levels		
Bethany & 19 Ave.	5.3	4.2	4.8	+0.6
Camelback & 19 Ave.	5.5	4.3	5.1	+0.8
Van Buren/Grand/7 Ave.	4.8	4.3	4.5	+0.2
Indian School & 7 St.	6.1	5.2	5.1	-0.1
McDowell & 7 S.t	6.1	5.4	5.3	-0.1
I-10 & 7 St.	4.0	3.4	3.4	0.0
Washington & 32 St.	4.0	3.6	3.8	+0.2
Apache Blvd & Rural	6.0	4.8	5.4	+0.6
Apache Blvd & McClintock	7.5	5.8	6.2	+0.4
Broadway & Dobson	7.0	6.9	5.5	-1.4
Broadway & Extension	4.3	3.8	4.0	+0.2
Apache Blvd & Price	3.4	2.9	3.9	+1.0
Average	5.3	4.6	4.8	+0.2

Source: *Central Phoenix/East Valley Light Rail Project: Final Environmental Impact Statement* (Valley Metro), p. 4-51.

rise by about 0.45 percent in the region and 1.23 percent in the corridor.[97] On balance then the proposed light rail system would appear to increase traffic congestion slightly.

Although the availability of light rail will slightly reduce the miles people drive, it will also slightly increase the time it takes to drive those miles. Replacing road lanes with rail tracks reduces capacity and slows traffic. In addition, trains given traffic signal preemption rights will disrupt synchronization and increase the frequency of stop-and-go traffic. Finally, train tracks will block direct access to many driveways and side streets along the route and will bar many left turns. That will result in more roundabout trips for many drivers.

With regard to environmental improvement, the Phoenix light rail proposal asserts that building a light rail line will reduce air pollution in the metropolitan region by around 800 tons per year.[98] That amounts to only two-tenths of one percent of the 400,000 annual tons of air pollution in the region.[99] But even that tiny impact is overstated, because it is based on the premise that every light rail passenger would otherwise drive a car, when most light rail riders will likely be former bus riders.[100]

Data on page 4-51 of Valley Metro's final environmental impact statement appear to confirm the proposition that light rail will increase pollution in the Phoenix area. Using 12 monitoring stations near the rail line, Valley Metro forecasted average carbon monoxide pollution levels for both one-hour and eight-hour measurement periods. In eight cases, the no-build alternative resulted in lower pollution levels. In only three cases did building light rail lead to lower projected pollution readings. In one case, there was no difference. Thus, carbon monoxide pollution was generally worse under the "build" scenario, suggesting that air quality may be slightly worse if the light rail system is built than if it is not built (see Table 15).

One explanation for the higher carbon monoxide readings is that they are a purely localized phenomenon caused by the existence of park-and-ride lots near the light rail line.[101] But with vehicle-hours of travel projected to increase under light rail – both in the corridor and in the region – it is possible that pollution levels may increase. If vehicles are expending more time in traffic, they will be burning more fuel and emitting more pollutants. Regardless of the direction of the environmental indicators, it appears the impact of a light rail transit system will be marginal. Given the availability of cost-effective alternatives for reducing pollution, light rail is not justified on the basis of environmental impact.

Under either the build or no-build option, pollution in Phoenix will be lower in 2020 than it is today. But that beneficial environmental result will be due almost exclusively to improvements in automotive and fuel technology.[102]

Although the availability of light rail will slightly reduce the miles people drive, it will also slightly increase the time it takes to drive those miles. Replacing road lanes with rail tracks reduces capacity and slows traffic. With vehicle-hours of travel projected to increase under light rail, it is possible that pollution levels may increase. Given the availability of cost-effective alternatives for reducing pollution, light rail is not justified on the basis of environmental impact.

Table 16: Estimated Geographic Distribution of Light Rail Taxes and Spending

City or town	Taxes paid[a] ($ millions)	Spending[b] ($ millions)	Local return on each tax dollar
Winners			
Tempe	57.5	128.8	2.24
Phoenix	508.5	987.8	1.94
Losers			
Mesa	171.7	85.9	0.50
Glendale	86.1	21.5	0.25
Scottsdale	86.8	0.0	0.00
Chandler	71.7	0.0	0.00
Gilbert	56.8	0.0	0.00
Peoria	46.9	0.0	0.00
Unincorporated	40.2	0.0	0.00
Goodyear	15.6	0.0	0.00
Avondale	15.5	0.0	0.00
Surprise	14.0	0.0	0.00
Buckeye	13.3	0.0	0.00
Fountain Hills	12.3	0.0	0.00
Queen Creek	4.6	0.0	0.00
Paradise Valley	4.4	0.0	0.00
Wickenburg	3.1	0.0	0.00
Litchfield Park	3.1	0.0	0.00
Cave Creek	2.8	0.0	0.00
Tolleson	2.1	0.0	0.00
El Mirage	2.0	0.0	0.00
Guadalupe	1.9	0.0	0.00
Carefree	1.4	0.0	0.00
Youngtown	0.9	0.0	0.00
Gila Bend	0.8	0.0	0.00

[a]Based on Arizona Department of Economic Security population projections.
[b]Total light rail expenditures by miles of track per city.

An Unbalanced Regional Plan

In the Phoenix region, public transportation spending is currently split, with about 85 percent spent on roads and 15 percent spent on transit. Under the MAG Transportation Plan, 68 percent of the 20-year regional transportation funds would be spent on roads, and 32 percent would be allocated to transit.[103] Assuming that buses and light rail will achieve the ridership goals projected in the plan, transit will account for slightly more than one percent of the person-miles of travel. By itself, light rail is projected to account for only 0.2 percent of the person-miles of travel in the region over the next 20 years.[104] If 32 percent of the transportation sales tax is spent on transit, for every dollar spent to benefit drivers of automobiles, $40 will be spent to benefit transit riders.

Whereas roads will serve every part of the metropolitan area, transit will not. In this regard, the light rail system is particularly deficient. Eighty percent of the proposed 57-mile system is within the borders of Phoenix. Only four of the 25 jurisdictions within Maricopa County will see any light rail service, yet taxpayers in every corner of the county will pay for it. In terms of the light rail service provided, taxpayers in those jurisdictions will get a zero rate of return for the money they have to pay (see Table 16). Indeed, because of the increased traffic congestion that light rail is likely to cause, they may experience negative returns.

In an important sense, public transit in the Phoenix area is not really a regional service, because the average length of riders' trips is only four miles. With buses in the Phoenix region averaging only 14 miles per hour, it is easy to understand why public transit is not attractive for longer regional trips. Unfortunately, light rail is unlikely to do much better. The fact that the trains are theoretically capable of speeds up to 55 miles per hour means little when they are operating in the middle of busy city streets and are stopping every mile or so to drop off and pick up passengers. The national average speed for light rail is 15 miles per hour.[105] Valley Metro claims its operation will beat this speed and average 21 miles per hour along the rail route.[106] Even at 21 mph, light rail is still slower than Valley Metro's estimate of automobile speeds in the year 2020. According to the environmental impact statement, if light rail is not built, automobiles will average 22 mph in 2020.[107]

Automobile travel also has the advantages of direct point-to-point access and no waiting: your car is waiting for you in your driveway; you don't have to walk to a transit stop; you leave when you are ready; you don't have to wait for a bus or train; you go straight to your destination; and you are not forced to abandon your vehicle partway through a trip and wait to transfer to a connecting vehicle. The superior convenience of automobiles ensures that they dominate person-miles of travel even under the most optimistic of assumptions made on behalf of transit.

Table 17: Relative Performance of Maricopa County Transportation Options

	Efficiency		Equity		Effectiveness
Mode	Cost per rider-mile ($)	Cost per trip ($)*	Rider share of cost (%)	Non-rider share of cost (%)	Share of regional travel (%)
Light Rail	2.90	12.39	5	95	0.2
Bus	1.87	8.04	15	85	0.9
Road/Auto	0.35	1.51	100	0	98.9

Sources: *Central Phoenix/East Valley Light Rail Project, FY 2004 Section 5309 Annual Report on New Starts* (Valley Metro), Table VII-1, average of first and last years, bus rider total multiplied by 3.77 mile average trip length for bus transit and light rail rider total multiplied by 4.28 mile average trip length for light rail in the *2003 Public Transportation Fact Book* (American Public Transportation Association), Tables 5 and 6. *Central Phoenix/East Valley Light Rail Project: Final Environmental Impact Statement,* (Valley Metro), Table S-8, *Central Phoenix/East Valley Light Rail Project: Final Environmental Impact Statement* (Valley Metro), average of first and last years. Regional Transportation Plan (Maricopa Association of Governments). The American Dream Coalition, http://americandreamcoalition.org/transport costs.xls. Jason Carey, *1999 Update of the Arizona Highway Cost Allocation Study* (Arizona Department of Transportation, August 1999), p. 13 and Nadia Mansour and John Semmens, *The Value of Arizona's State Highway System: A Corporate Style Financial Analysis* (Arizona Department of Transportation, October 1999), p. 11.
*based on typical transit trip length of 4.3 miles.

From the data it is clear that the automobile/roadway combination provides a more efficient, more equitable, and more effective means of meeting the region's transportation needs than either bus or light rail. The claim that expanding public transit is necessary to produce a more "balanced" transportation system is not persuasive.

Only the tiny minority that has no alternatives or happens to live and work within a few hundred feet of rail or bus stops will find transit a satisfactory mode of travel for the relatively short trips they take. Thus, public transit will continue to be overwhelmingly local in nature. If transit is to be publicly subsidized it is more appropriate that the decision to do so be made locally rather than regionally.

Efficiency, Equity and Effectiveness

To evaluate the merits of any prospective transportation policy or program, we should consider the criteria of efficiency, equity, and effectiveness. Table 17 compares light rail, bus, and auto passenger transportation modes. From the data it is clear that the automobile/roadway combination provides a more efficient, more equitable, and more effective means of meeting the region's transportation needs than either bus or light rail. The claim that expanding public transit is necessary to produce a more "balanced" transportation system is not persuasive.

Cost-Effective Alternatives to Transit

Improving urban transportation is a goal virtually everyone can support. The real issue is how to achieve the best results at the least cost. With that in mind, here is a brief look at more cost-effective and promising answers to urban travel needs and air pollution problems.

Improve the Road System

The auto/road transportation combination has been a great success. The freedom and mobility the combination provides is the explanation for its domination of the urban travel environment. In Phoenix, cars provide more passenger transportation in one day than the transit system provides in three months.[108] As good as the road system is, it can always be made better. Some of the options for improvement include the following:

Build More Freeways

Some observers in Maricopa County have suggested that "we cannot build our way out of congestion."[109] Strictly speaking, that is not true. If cities are willing to spend the money, they can build enough freeway capacity to handle growing traffic. Whether spending that money is a good idea or not is a different question. Under the MAG Transportation Plan, new urban freeways are projected to cost about $12 million per lane mile to build.[110] Both freeways and light rail tracks are expensive to build. The key distinction is that freeways would likely carry 40 times as many person-miles of travel per dollar of tax expenditure as the light rail line.[111] A study done by the Road Information Program found that areas active in increasing regional road capacity experienced congestion increases that were 40 percent less than areas less active in expanding road capacity.[112] If the goal is to reduce traffic, it would be far more cost-effective to build freeways than new rail lines.

Improve Traffic Signal Coordination

For city streets, a key policy initiative should be improving traffic flows by optimizing coordination among traffic signals, what is often referred to as traffic signal synchronization. Poorly timed traffic signals can increase traffic delay and fuel consumption by 40 percent.[113] The simplest means of synchronizing traffic signals is to time the red/green cycle to correspond to the normal speed of vehicles moving in the peak volume direction. Modern electronics and computer technology permit sophisticated techniques for controlling and improving traffic flow.

States that have pursued improvements in traffic signal coordination have reported good results, and the benefits to highway users in terms of saved time and fuel have been substantial. A traffic signal coordination program in California reported a reduction in traffic delays of 14 percent.[114] A study in Texas reported a reduction in traffic delays of 30 percent.[115] In Arizona a study found

Some observers in Maricopa County have suggested that "we cannot build our way out of congestion." A study done by the Road Information Program found that areas active in increasing regional road capacity experienced congestion increases that were 40 percent less than areas less active in expanding road capacity.

reductions in traffic delay of 27 percent when traffic monitoring computerized signals were used.[116] If similar results could be achieved throughout the Phoenix metropolitan region, traffic congestion in the area could be reduced by about eight percent. It would affect traffic at all hours of the day and would save drivers the cost of unnecessarily burned fuel.

Diverting some discretionary travel to off-peak periods by way of a pricing differential would reduce traffic congestion and improve the efficiency of the road system. A study done in the state of Washington called congestion pricing the best strategy for reducing traffic congestion.

Replace Existing Highway Taxes with Congestion-Based Pricing[117]

Roads are subject to wide fluctuations in demand. As a result, road capacity that is inadequate during some hours of the day is grossly underused at other times of the day. We are accustomed to thinking of peak period traffic as commuters driving to and from work, but not all peak period trips are work commutes. In Southern California more than 60 percent of peak period trips are not work-related.[118] Another estimate of nonwork trips during the peak traffic periods placed the figures at 50 percent for the morning peak and nearly 70 percent for the evening peak.[119]

Diverting some discretionary travel to off-peak periods by way of a pricing differential would reduce traffic congestion and improve the efficiency of the road system. A study done in the state of Washington called congestion pricing the best strategy for reducing traffic congestion.[120] Private sector businesses faced with similar demand fluctuation often resort to peak/off-peak pricing structures to try to smooth out fluctuations and make more efficient use of their existing capacity. Businesses that have used this strategy to good effect include movie theaters, airlines, electric power companies, hotels, and phone companies. In fact, the widespread use of prices that vary according to the volume of demand is more aptly termed "commercial pricing," according to one eminent transportation economist.[121]

Economists who have dealt with the issue of traffic congestion are virtually unanimous in their support of pricing as the most effective solution.[122] Nonpricing methods of attempting to reduce traffic congestion have limited effectiveness, and their impact on peak period traffic is frequently measured in fractions of a percentage.[123] In contrast, congestion pricing could readily reduce peak traffic volume by 25 percent or more.[124] For example, congestion pricing in Singapore is estimated to have reduced peak period traffic by 65 percent.[125] One study estimated net annual benefits of $3.0 to $5.3 billion for a limited set of severely congested urban freeways in the United States.[126] So persuasive is the evidence for congestion pricing that one researcher has called its implementation "inevitable."[127]

In the past, the technology to employ efficient road pricing was unavailable. Such road pricing as exists in most places still uses the cumbersome "stop-pay-toll" methods that are not very appealing to motorists. Fortunately, stopping vehicles to collect payment for use of the roads is no longer necessary. Technology employed in the Hong Kong experiment with electronic road use pricing included on-board transponders (also known as "electronic license plates"), roadside toll readers, video recorders, and computerized billing.[128] That process was assessed as technically feasible and cost-effective. Inexpensive transponders make charging for highway use as simple as charging for long distance telephone use.[129]

One final caveat for Maricopa County transportation planners: congestion pricing should replace existing highway user taxes rather than be added on top of those taxes, so that the county avoids burdening road users with double payments for the same service. Moreover, this demand-priced user fee presents a more equitable funding mechanism than blanket taxes because motorists are paying for the freeway system in actual proportion to how much they use it.

Convert HOV Lanes to HOT Lanes

Currently, high-occupancy-vehicle (HOV) lanes on Phoenix-area freeways are underused. Despite a higher potential person-mile carrying capacity, HOV lanes actually accommodate only about half as many passengers per lane per hour as the abutting general use lanes during congested periods.[130] California assemblyman Tom McClintock has suggested that traffic congestion could be eased by simply converting HOV lanes into general purpose lanes, and that would indeed be better than the current system.[131] But there is a much better alternative. Instead of letting unused HOV capacity go to waste, it can be "rented" to single occupant vehicles (SOVs). Drivers of SOVs who were willing to pay a fee for the privilege would be permitted to drive in the underused HOV lanes during the periods when the general purpose lanes were congested. Thus, the previously exclusively HOV lanes would be converted into high occupancy/toll (HOT) lanes.[132] On California's State Route 91 tollway, high occupancy vehicles travel for free while SOVs pay a toll that is based on the amount of congestion in the parallel general use lanes. The HOT lanes provide some relief from traffic congestion, not only for the SOVs paying to get into the HOV lane, but also for the SOVs left behind in the general purpose lanes. Implementation of HOT lanes could also generate revenue that could be used to build more HOV lanes.

Despite a higher potential person-mile carrying capacity, HOV lanes actually accommodate only about half as many passengers per lane per hour as the abutting general use lanes during congested periods. Instead of letting unused HOV capacity go to waste, it can be "rented" to single occupant vehicles.

Implement Cost-Effective Alternatives to Driving Alone

Encourage Carpooling

Nationally, carpooling accounts for about 16 percent of commuter trips, or five times as many person-trips as transit.[133] One factor that deters many travelers from carpooling is the inflexibility that it often imposes on participating members. On the one hand, participants do not want to inconvenience their fellow carpool members by making them wait in the event work demands run past the normal quitting time. On the other hand, participants have a fear of being stranded and missing the carpool

One means of restructuring transit would be to modify existing subsidy programs so that they are less damaging to competition. Currently, the subsidies from federal, state, and local taxes flow directly to transit system operators. Instead, the focus of the subsidies could be shifted to the riders. That could be accomplished by selling public transportation "tokens" to prospective riders at a price comparable to current fares.

connection (or last bus) if they must work overtime. A fairly successful remedy is the "guaranteed ride home" program employed by some companies. Under those programs, employers bear the expense of a taxi for the employee's ride home. On a per-ride basis, that sounds expensive – one study found an average cost of $53 – but because the guaranteed rides are infrequently used they may be more appropriately viewed as a cost-effective "insurance" premium.[134]

Restructure Public Transportation

Rider-Based Subsidies

One means of restructuring transit would be to modify existing subsidy programs so that they are less damaging to competition. Currently, the subsidies from federal, state, and local taxes flow directly to transit system operators. Instead, the focus of the subsidies could be shifted to the riders. That could be accomplished by selling public transportation "tokens" to prospective riders at a price comparable to current fares. Transit operators would redeem those tokens for amounts comparable to the current per-trip cost of the Phoenix transit system. Discounts from the normal fares could be handled through social service agencies. Social service agencies wanting to provide even larger subsidies for certain categories of public transportation users (such as the indigent or elderly) could buy the tokens at the regular price and resell them at a lower price (or give them away) to their clients. Fundamentally, this is the most effective way to provide transit for those with no other transportation options.

Zone-Based Fare Systems

The "flat" fare structures typically employed by transit systems are both inefficient and inequitable. Passengers traveling longer distances are undercharged relative to those traveling shorter distances, thereby discouraging more cost-effective shorter trips and encouraging more costly longer trips. Buses therefore incur more empty seat miles venturing further from the central core of the city, diminishing the performance of the total system. Implementing a zone-based fare system would create a more efficient and equitable fare structure. Trips within one zone would cost one token; trips involving travel in two zones would be priced at two tokens, and so forth. Because the average trip length for transit is only four miles, most trips in a zone-based system would not involve more than one "zone." By using a zone-based fare structure, use of public transportation in the most congested areas would be encouraged, while use of public transportation for costly and inefficient long distance trips would be discouraged.

Under a zone-based structure, public transportation tokens could be sold through city offices, convenience markets, vending machines, and other outlets near public transportation routes. The tokens would be redeemable only by bona fide public transportation operators. To qualify as a bona fide public transportation operator, a business would have to have appropriate vehicles and keep financial and operating records documenting the number of passengers served. Audits of those records and spot checks of on-the-road operations would need to be conducted to ensure that the redeemed tokens were actually acquired by providing transportation.

Deployment of Subsidy Funds

Because the subsidies provided by federal, state, and local taxes are for designated public transportation purposes, operators redeeming the tokens would be required to demonstrate that the appropriate portions of the subsidy funds received from redeeming tokens were being deployed as required by law for capital and operating expenses. Basically, 50 cents of every dollar's worth of tokens redeemed would be subject to the requirement that federal aid for "capital" expenditures (about 20 to 25 percent of the total government subsidy) and federal aid for operations (about 10 percent of the total government subsidy) be reinvested by the recipient public transportation firm in capital and operating expenditures. Another alternative would be for the city to own the vehicles, financed through federal aid, and lease them to private sector operators, with leases structured to accommodate competition. Since the amounts that private sector firms would be willing to pay to lease the vehicles would be directly related to the functionality and efficiency with which the vehicles could be operated, the city would have a strong incentive to procure the types of vehicles needed in the public transportation marketplace.

The Potential of Private Transit Provision

Rather than preserving their traditional public transit monopolies, cities in Maricopa County could create more opportunities for purveyors of private transit services. Private sector transit services would likely use vans or small buses that would follow semi-fixed routes. They could offer more door-to-door service than larger buses, and they would reduce both waiting time and in-vehicle travel time for passengers. Riders of private transit services in other cities report that they feel safer than they do on city buses, since private drivers are more likely to refuse to pick-up disorderly or dangerous passengers. Private transit services are also popular in corridors that serve the transit dependent.[135] Private transit services in a number of U.S. and foreign cities have succeeded in offering higher quality than public transit buses at lower prices.[136] The potential of private sector transit has not been fully realized because private operators currently must compete with heavily subsidized municipal bus systems.[137] Because of local and federal government subsidies, municipal bus operators must cover only one-fifth of their costs from earned revenue; that means private sector operators would have to be five times as efficient in order to break even charging competitive fares.

Private transit services in a number of U.S. and foreign cities have succeeded in offering higher quality than public transit buses at lower prices.[136] The potential of private sector transit has not been fully realized because private operators currently must compete with heavily subsidized municipal bus systems.

Privately operated transit has been shown to operate at costs considerably lower than municipally owned transit.[138] Thus, it seems likely that private buses and vans could operate profitably under a restructured transit system. Those reforms would help the county move toward a more self-sustaining public transportation system and away from the growing deficits and tax increases that have plagued the traditional approach to municipal transit. Subscription buses have provided service for half the cost of public transit buses in such cities as Chicago and Los Angeles.[139] Again, the significant subsidy to municipal operators discourages private entrants into this market.

One way to encourage private provision of service would be to offer some level of subsidy (proportionately lower than that given to public operations) to qualified private operators. This approach would help private operators compete with highly subsidized public operators, but would still result in a net savings. Additionally, initial contracts and subsidy levels could be set by a "Demsetz auction,"[140] whereby the firm proposing the lowest subsidy level (cost of contract) or passenger fare (if the subsidy level is set) is awarded permission to provide service. This approach would allow efficient initial private contracting without prior knowledge of how to set subsidy/fare parameters, and additionally avoids granting a contract that results in monopolistic behavior. In either case, municipal transit authorities retain the power to regulate the overall provision of transit in their jurisdiction.

Encourage More Innovative Employment Practices

Because most traffic congestion occurs during rush hours, when employees are commuting to and from jobs, some changes in employment practices might help to improve the efficiency of the county's roads and freeways. Some potentially helpful measures are listed below.

The Compressed Work Week

To the extent that business can convert the traditional 40-hour workweek from five eight-hour days to four ten-hour days, the number of work trips could be reduced and peak-hour traffic congestion partially mitigated.

Flextime

To the extent that companies can use flextime to spread out work trips over a wider interval, the peaks of traffic will be lower. That may help reduce some of the capacity overloads that aggravate the traffic congestion problem.

Proximate Commuting

The overwhelming majority of commuters make their work trips in single-occupant vehicles. Instead of trying to get commuters to give up their cars, proximate commuting seeks to shorten their work trips. The work trip is shortened by moving the place of employment closer to the employee's home. While not a viable strategy for many types of businesses, proximate commuting would appear highly suitable for businesses that have multiple work sites, such as banks, restaurant chains, retail chains, public schools, and some government offices (for example, Motor Vehicle Division offices that issue driver's licenses and registrations). If companies and government agencies transfer their workers to sites closer to their homes, their commute distances will be reduced, thereby reducing some of the peak period traffic volume.

During 15 months in Seattle in 1994-1995, Key Bank of Washington gave nearly 500 employees at 30 branches the opportunity to participate in a proximate commuting demonstration project. About one in six eligible employees elected to participate and reduced their average commute distance by 65 percent. Because the employees with the longest trips were more likely to choose to participate, the average reduction in commute miles per bank branch was 17 percent.[141]

Another attractive feature of proximate commuting is that it does not require large public outlays. Employees of multiple site businesses participate because of the opportunity to save time and money on their daily commutes. Employers find the system attractive because they can extend a money-saving benefit to employees without a cash outlay. Proximate commuting is a "win-win" solution.

Telecommuting

Telecommuting reverses the traditional work process by moving the work to the workers. Common modes of transporting the work include telephone, facsimile, and e-mail. The contrast in time and energy required to transport a person versus transporting the work is quite dramatic. Moving a person 12 miles in an automobile twice per workday consumes about 50 minutes of time and costs a little over $7 (29 cents/mile x 12 miles x 2 commute trips/workday). Traveling that same distance by bus in Phoenix under the county's planned expansion will cost almost $40 ($1.59/mile x 12 miles x 2 commute trips/workday in taxes plus about $1.20 in fare revenue). By light rail, the commute will cost about $67 ($2.75/mile x 12 miles x 2 commute trips/workday in taxes plus about $1.20 in fare revenue).[142] But moving a person's work via telecommuting would take a few minutes by FAX or a few seconds by Internet. Since the transmission of data to a workplace 12 miles away would be a local call, the cost for using the phone lines would be just a few pennies.[143]

The potential reduction of traffic congestion and air pollution from increased telecommuting seems promising. A pilot project in California indicated that telecommuters reduced their peak-period trips by 60 percent, their total vehicle miles driven by 80 percent, and their freeway use by 40 percent. The program also inspired many of the participants to seek out shopping, recreation, and other nonwork-related activities at locations closer to their homes, even on

A demonstration project in the Seattle metropolitan region found that telecommuters reduced vehicle miles of travel by 66 percent and the number of workday trips by 32 percent.

nonworkdays.[144] A demonstration project in the Seattle metropolitan region found that telecommuters reduced vehicle miles of travel by 66 percent and the number of workday trips by 32 percent. [145]

While reducing traffic congestion and improving air quality are public-spirited reasons to promote telecommuting, there are plenty of other reasons why many workers should be enthusiastic about telecommuting. Telecommuting workers save themselves the time it would otherwise take to travel to work, which effectively gives them an increase in their hourly rates of pay. They save auto operating costs and/or transit fares. Additionally, a variable road-pricing scheme would further incentivize this preference. They may also obtain non-economic benefits, such as spending more time with their families, avoiding the stress and risks associated with driving in traffic, setting their own work hours, and gaining comfort and familiarity.

Employers of telecommuting workers may be able to save money by reducing the amount of office space needed. An analysis by American Express estimated the annual savings in office expenses for each telecommuting "full-time-equivalent" employee at $15,000 per year.[146] In addition, employers seem to get improved productivity out of their telecommuting workers. The benefits enjoyed by telecommuting employees may be roughly equivalent to getting raises and upgraded working conditions (at no cash cost to the employer) and may serve to motivate better performance. Typical productivity gains are reflected in faster completion of work assignments, fewer sick days, better time management, and increased morale. Pacific Bell estimated a net productivity gain of 20 percent and savings of at least $500,000 in office space costs from its telecommuting program.[147] In fact, it appears that output gains in the 20 percent range are common for telecommuting workers.[148]

Implement Alternative Air Quality Measures

Because part of the rationale behind the advocacy of transit expansion is concern over air quality, Maricopa County policymakers should consider measures that, while not reducing traffic congestion, may help reduce vehicle caused air pollution. It is widely acknowledged that a minority of vehicles is responsible for a majority of pollution.[149] Getting those vehicles tuned up or removed from traffic is likely to have a far greater impact on air quality than any other option. Some potentially helpful anti-pollution measures include the following:

Super Emitter Measures

A 1996 governor's task force in Arizona recommended four options for reducing the emissions of the worst-polluting vehicles: (1) a vehicle license surcharge, which high-polluting vehicles would have to pay in order to register their vehicles; (2) an emission fee assessed at the emission testing site; (3)

retrofitting older vehicles with catalytic converters; and (4) accelerating the "retirement" and scrapping of older vehicles. All of those measures would likely have large impacts on air pollution (about 30 times greater than even the most optimistic projections for an expanded transit system) and relatively small costs to implement (about 95 percent to 99 percent less than transit expansion).[150]

Mobile Emission Enforcement

Mobile emission enforcement helps to overcome the "clean-for-a-day" problem that occurs with stationary annual testing. Under mobile emissions enforcement, a vehicle could be checked while it is moving, at a variety of locations and at any time. Drivers would need to keep their vehicles tuned year-round, not just on an inspection day largely of their own choosing. The necessary technology for mobile emission enforcement has been found to be accurate and cost-effective.[151]

Conclusion

By the standards of efficiency, equity, and effectiveness, public transit in America is an unproductive investment of taxpayer resources. Transit service is typically of lower quality than travel by automobile, and average travel times for transit are long compared to times for travel in cars. Given those drawbacks, it should not be surprising that transit carries such a small share of urban travel. Transit also involves a massive transfer of resources from nonriders to riders, with taxpayers picking up 80 percent of the cost of transit rides. And transit promises very little – if anything – in the way of environmental improvement or relief from traffic congestion.

Large subsidy efforts by federal and local governments over the past 35 years have failed to reverse the long-term decline of transit since the end of World War II. Instead, each new tax subsidy has merely deepened transit deficits, and those outlays have imposed real losses on the economy, at both at the national and local levels.

Given the inefficiency, unfairness, and ineffectiveness of transit systems, Maricopa County's taxpayers, commuters, and policymakers must reassess the regional transportation plan proposed by the Maricopa Association of Governments. If the county persists in spending the proceeds of the half-cent sales tax on ill-considered transit ventures such as light rail, county taxpayers could lose substantial economic resources.

The good news for Maricopa County is that there are several excellent alternatives to expanding transit. First, the county could focus resources on improving its road system. Options include building more freeways, improving traffic signal coordination, and replacing existing highway taxes with congestion-based pricing. Another option currently in use in other states is

Given the inefficiency, unfairness, and ineffectiveness of transit systems, Maricopa County's taxpayers, commuters, and policymakers must reassess the regional transportation plan proposed by the Maricopa Association of Governments. The good news is that there are several excellent alternatives to expanding transit: freeways, traffic signal coordination, congestion-based pricing, and high occupancy/toll lanes, to convert underutilized high-occupancy-vehicle (HOV) lanes into high occupancy/toll (HOT) lanes, effectively renting unused HOV capacity to single occupant vehicles.

Second, the county could implement cost-effective alternatives to driving alone. Options include encouraging carpooling among commuters, restructuring public transportation through the use of competitive provision and efficiency pricing, and promoting privately operated subscription buses. Third, the county could encourage more innovative employment practices, including more use of a compressed work week, flextime, proximate commuting, and telecommuting.

Finally, the county could consider the use of alternative measures for improving air quality. There are several ways to target the relatively few super-emitting vehicles that cause the most pollution, and mobile emission enforcement can help to overcome the problem of high-polluting vehicles that test clean during annual inspections.

By exploring and pursuing productive transportation policies that actually have a chance of benefiting the people of the region, Maricopa County can avert its present course and put itself back on the road toward a sound transportation system.

NOTES

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2. American Public Transit Association, *Public Transportation Fact Book* (Washington, DC, 1996), p. 77. Hereinafter *Public Transportation Fact Book.*

3. Alan Altshuler, "Changing Patterns of Policy: The Decision Making Environment of Urban Transportation," *Public Policy* (Spring 1977), pp.171-203; *Public Transportation Fact Book* (various years); and U.S. Department of Transportation, Federal Highway Administration, *Highway Statistics* (Washington, DC, various years). Herein after *Highway Statistics.*

4. American Public Transportation Association, *Public Transportation Fact Book* (2003), Table 5, p. 31. Hereinafter *Public Transportation Fact Book.*

5. Altshuler, pp. 171-203; and updated figures by the author based on data from the *Public Transportation Fact Book* (various years); *Highway Statistics* (various years); and Alan Pisarski, *Commuting in America II* (Washington, DC: Eno Transportation Foundation, 1996), p. 49. To make the comparison consistent over time, the table shows vehicle-miles of travel for automobiles rather than person-miles of travel. Vehicle occupancy rates for the early years of the comparison are not available. Wendell Cox and Randal O'Toole correctly point out that, using current estimates of automobile occupancy, transit's share of travel is about 2 percent. Whether one uses that figure or the more generous 3 percent, there can be no doubt that transit accounts for a very small share of urban travel.

6. Department of Commerce, Bureau of the Census, *Historical Statistics of the United States* (Washington, DC, 1975), p. 297; and Department of Commerce, Bureau of the Census, *Statistical Abstract of the United States* (Washington, DC, 2002), http://www.census.gov/statab/www. Hereinafter *Statistical Abstract.*

7. *Public Transportation Fact Book* (various years).

8. Erik Ferguson, "Demographics of Carpooling," Transportation Research Record 1496 (Washington, DC: The National Academies, Transportation Research Board, 1995).

9. Pisarski, p. 56.

10. Ibid., p. 60 and *Public Transportation Fact Book* (2003), Table 12, p. 35.

11. For example, the operating cost per passenger for the express routes in Phoenix (the ones that run only during the peak period to carry downtown workers to and from their jobs) is about $2.40. The system's average operating cost per passenger is about $1.50. See

Short Range Transit Plan FY 1996-97 through 2000-01 (Phoenix: Regional Public Transportation Authority), p. 28; and U.S. Department of Transportation, Federal Transit Administration, *Transit Profiles: Agencies in Urbanized Areas Exceeding 200,000 Population* (Washington, DC: December 1995), p. 193.

12. Congressional Budget Office, *Public Works Infrastructure: Policy Considerations for the 1980s* (Washington, DC, April 1983), p. 49.

13. *Public Transportation Fact Book (*various years), Table 26; and *Statistical Abstract,* Table 2: Population 1960-2000.

14. *Public Transportation Fact Book* (2003), Tables 48, 61, 63; and U.S. Census Bureau, http://quickfacts.census.gov/qfd/states/00000.html.

15. Arizona Department of Transportation, *Trends in Transit Privatization* (Phoenix, April 1986), p. 7.

16. Quoted in Rick Henderson, "Spinal Tap," *Reason* (April 1997), p.7.

17. *Statistical Abstract,* Table 691: Purchasing Power of the Dollar 1950 to 2000.

18. *Public Transportation Fact Book* (1979), pp. 21-22.

19. It is unlikely that the "customers" of public transit would have been willing to pay those soaring costs. That important point is often overlooked in assertions that deficit-ridden public transit is serving a "vital need." The only objective measure of need that we can ever have is the amount of money customers willingly pay for something. The losses accruing to public transit prove that the assertions of a vital need being met are unsubstantiated. The unwillingness to ask transit riders to pay the full cost of the service is proof that the people who operate these systems do not really believe that the service is worth the cost of providing it. The objective evidence is that neither transit riders nor transit providers value the service at more than it costs to provide it. Perpetual deficits mean that most public transit systems are converting resources from more valued uses into less valued uses. Individuals, in the aggregate, would not voluntarily waste their resources in that way.

20. *Public Transportation Fact Book* (2003), Tables 61, 63.

21. Ibid., Tables 48, 61, 63.

22. *Public Transportation Fact Book* (various years); and *Public Transportation Fact Book* (2003), Tables 30, 48, 61, 63.

23. The American Dream Coalition, http://americandreamcoalition.org/transportcosts.xls.

24. Pisarski, p. 85.

25. The relatively low cost of operating an automobile in terms of both time and money is enhanced by its comfort and

convenience. Public transit requires customers to walk to stations, wait in the hot sun or driving rain, endure frequent delays, and perhaps ride standing.

26. American Automobile Association, Your Driving Costs (http://www.aaaaz.com/, Accessed December 31, 2003).

27. David Aschauer, *Transportation Spending and Economic Growth: The Effects of Transit and Highway Expenditures* (Washington, DC: American Public Transit Association, 1991), p. 10. Highway expenditures were depicted as generating only half as many benefits per dollar spent on them (benefit/cost = 1.50).

28. Donald H. Camph, *Dollars and Sense: The Economic Case for Public Transportation in America* (Washington, DC: Campaign for Efficient Passenger Transportation, June 11, 1997).

29. National Business Coalition for Rapid Transit, "The Economic Importance of Public Transit," http://65.114.146.18/documents/advocacy_economic_report.pdf .

30. Cambridge Systematics, Public Transportation and the Nation's Economy (Washington, DC: American Public Transportation Association, October 1999), p. E-1; http://www.apta.com/research/info/online/documents/vary.pdf.

31. Some of the money spent on public transit employs workers in the construction of rail lines, the driving of buses, and so on. This spending further stimulates the economy as these employed workers spend their wages. These "ripple effects," sometimes referred to as "multiplier effects," are not unique to public sector outlays; all economic activity generates such effects. Before concluding that public transit expenditures are a plus for the economy, one must compare their effects with those of alternative uses for the money spent on transit.

32. About 350,000 of these jobs are in the transit industry itself (see *Public Transportation Fact Book,* 2003), p. 53. Another 650,000 are the "ripple effect."

33. *Public Transportation Fact Book* (2003), Tables 6, 48, 61.

34. Ibid., Tables 6, 48, 61.

35. The American Dream Coalition, http://americandreamcoalition.org/transportcosts.xls.

36. Peter Gordon and Harry Richardson, *The Facts about Gridlock in Southern California* (Los Angeles: Reason Foundation, August 1993).

37. Congressional Budget Office, *Public Works Infrastructure,* p. 48.

38. For example, according to Glen Yago in *The Decline of Transit* (Cambridge University Press, 2003): "After World War II, urban planners embraced highway transportation as the solution to urban congestion, while mass

transit was shunned as outmoded and appropriate only for older, densely populated cities."

39. *Highway Statistics* (2001), p. IV-9.

40. *Public Transportation Fact Book* (2003), pp. 87, 99.

41. Department of Transportation, *2001 National Household Transportation Survey,* http://nhts.ornl.gov/2001/html_files/trends_ver6.shtml. This figure does not include credit for the use of roads to move freight, which would appear to merit a share of public transportation expenditures.

42. *Public Transportation Fact Book* (2003), p. 32.

43. Ibid., pp. 87, 99, 105. Passenger fare divided by capital and operating costs.

44. *Highway Statistics* (2001), p. IV-9.

45. Randal O'Toole, *Ten Transit Myths* (Los Angeles: Reason Foundation, September 1998); Wendell Cox, *US Streets and Highways: User Fees and Subsidies: The Difference,* http://www.publicpurpose.com/pp-hwyuser$.htm; and Rayola Dougher, *Estimates of Annual U.S. Road User Payments vs. Annual Road Expenditures* (American Petroleum Institute, March 1995).

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47. Economists refer to costs (or benefits) imposed upon society as "externalities."

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51. Department of Transportation, Federal Highway Administration, Office of Program Development, *Transportation Air Quality Fact Book,* http://www.fhwa.dot.gov/environment/aqfactbk/factbk14.htm.

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54. Joseph Bast et al., *Eco-Sanity* (Lanham, MD: Madison Books, 1994), p. 13.

55. "1996 Discover Awards: Automotive and Transportation," Discover (July 1996).

56. Economists sometimes refer to this

potential demand scenario as a "network effect."

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58. *Public Transportation Fact Book* (various years).

59. Calculated on the basis of *Public Transportation Fact Book* (various years).

60. Hans W. Korve et al., *Light Rail Service: Pedestrian and Vehicular Safety, TCRP Report 69* (Washington, DC: Transportation Research Board, 2001), http://www.national-academies.org/trb/bookstore).

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62. *Public Transportation Fact Book* (2002), Table 75.

63. These figures are calculated from data appearing in the following sources: *Public Transportation Fact Book* (2002), Tables 30, 42, 71; and *Highway Statistics* (2000), Tables VM-1, FI-10.

64. Department of Transportation, National Highway Traffic Safety Administration, *Traffic Safety Facts 2001* (Washington, DC: http://www-nrd.nhtsa.dot.gov/pdf/nrd-30/NCSA/TSFAnn/TSF2001.pdf, accessed December 31, 2003), Tables 36 and 74; *Public Transportation Fact Book* (2003), Tables 18, 6, 40; and *Highway Statistics* (2001), Tables VM-1, FI-10.

65. Valley Metro (Phoenix, various years).

66. *Central Phoenix/East Valley Light Rail Project, FY 2004, Annual Report on New Starts,* Section 5309 (Phoenix: Valley Metro, August 2002), http://www.valleymetro.org. Hereinafter *Central Phoenix.*

67. Ibid.

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69. Ibid. Annualized light rail fare revenue of $5.2 million divided by annualized light rail ridership of 7.9 million.

70. Ibid. Annualized light rail fare revenue of $5.2 million divided by annualized light rail costs of $97.8 million.

71. Maricopa Association of Governments, *Regional Transportation Plan* (Phoenix, 2003). Hereinafter *Regional Transportation Plan.*

72. Calculated from data in Ibid. Wendell Cox found an even lower cost per added person-mile of travel (2 cents) for roadways (http://www.publicpurpose.com/ut-tr$fr1970.pdf)

73. Calculated from data in *Central Phoenix.*

74. The American Dream Coalition, http://americandreamcoalition.org/transportcosts.xls.

75. Valley Metro, *Frequently Asked Questions,* p. 2, http://www.valleyconnections.com/content_04/index.cfm.

76. *Public Transportation Fact Book* (2003), p. 43.

77. The cost per passenger for the Phoenix region is considerably higher than national averages for two likely reasons. First, the Phoenix light rail addition and bus transit expansion are brand new purchases at today's costs. Other cities initial costs were incurred in earlier eras when prices of equipment and construction were lower. Second, because Phoenix is more spread out than many of the eastern cities, population densities are lower and costs are therefore amortized over fewer passengers per mile of track or hour of service.

78. *Regional Transportation Plan.*

79. The ratio of $.06 per person-mile for highways is 1/40 the $2.75 cost per person-mile for light rail. Hence, rail-riding taxpayers receive 40 times the benefit per tax dollar as do nonriders.

80. *Regional Transportation Plan.*

81. *Central Phoenix.* This comparison is in line with typical freeway/light rail comparisons. Wendell Cox finds that on average new U.S. light rail lines carry 80 percent less volume than a single freeway lane couplet (two lanes of freeway, one operating in each direction), http://www.publicpurpose.com/ut-fwy&lrt.htm.

82. Central Phoenix, p. V-3. Bus cost is calculated by subtracting the light rail cost from the total.

83. Bus rapid transit would be quicker because it has fewer stops than light rail transit, which makes stops every mile or so along the corridor.

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105. *Public Transportation Fact Book* (2003), Table 20, p. 43.

106. *Central Phoenix: Final Environmental Impact Statement,* p. 1-8.

107. Ibid., p. S-18. Vehicle miles divided by vehicle hours from Tables S-8 & S-9.

108. Ibid., Table S-8 (average of first and last year) and Table VII-1 (average of first and last years). Bus rider total multiplied by 3.77 mile average trip length for bus transit and light rail rider total multiplied by 4.28 mile average trip length for light rail in *Public Transportation Fact Book* (2003), Tables 5 and 6.

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140. Harold Demsetz, "Why Regulate Utilities," *Journal of Law and Economics* 11 (1968). This type of auction is a closed-bidding scenario wherein no one knows anyone else's bid.

141. Gene Mullins and Carolyn Mullins, *Proximate Commuting: A Demonstration Project of a Strategic Commute Trip Reduction Program* (Seattle: Washington State Department of Transportation, Office of Urban Mobility, 1995), p. 69.

142. *Central Phoenix,* p. V-3 and Table 9.

143. Clearly, telecommuting is not appropriate for all types of work. It is largely restricted to work that involves the production of information. The types of jobs that would be amenable to telecommuting would include "white-collar" office jobs such as accountant, statistician, secretary, data processor, engineer, and so on. Jobs requiring the physical presence of the employee, such as manufacturing assembler, waiter, barber, and police officer, would not be suitable candidates for telecommuting.

144. Katherine Turnbull et al., *Potential of Telecommuting for Travel Demand Management* (College Station, TX: Texas Transportation Institute, 1995).

145. Dennis K. Henderson and Patricia L. Mokhtarian, *Impacts of Center-Based Telecommuting on Travel and Emissions: Analysis of the Puget Sound Demonstration Project* (Davis, CA: University of California, 1996), p. 26.

146. Comment made by Al Gore at a Phoenix Economic Discussion Group dinner on June 11, 1997.

147. Katherine Turnbull et al. *Potential.*

148. U.S. Department of Transportation, Telecommuting: Moving the Work to the Workers (Washington, DC: September 1991).

149. Michael Fumento, *Science under Seige* (New York: William Morrow, 1993), p. 325.

150. *Task Force Report,* p. S-11.

151. Donald Stedman et al., *On-Road Remote Sensing of CO and HC Emissions in California* (Sacramento, CA: California Air Resources Board, February 1994).

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