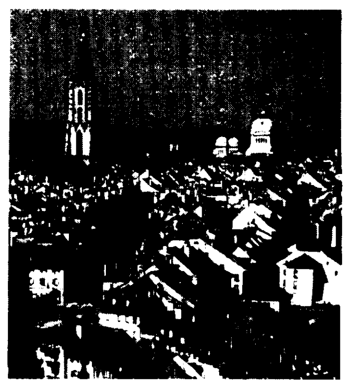
Is the U.S. System Energy-Efficient? A Comparison With Europe 3

In arguing about the potential for improving U.S. transportation energy efficiency, it is tempting to point to Western Europe as a model. Although average Western European "per capita" income levels are similar to those in the United States, the average citizen of a European OECD (Organization for Economic Cooperation and Development) country uses far less energy for travel than an average U.S. citizen. In 1990, citizens of Great Britain, West Germany, France, and the Scandinavian countries used about 30 to 40 percent as much and the average Italian citizen about one-fourth as much energy as U.S. citizen s.[1] This large disparity may not seem surprising given the similar (although inverted) disparity in energy prices-in 1990, European gasoline prices averaged about three times those in the United States, and Italian prices four times as much—but there may be additional reasons for the energy use differential.



US. POTENTIAL TO MOVE TOWARD EUROPEAN TRANSPORT ENERGY LEVELS

The large differences between European and U.S. per capita transport ation energy use raise two obvious questions. First, do the differences reflect primarily differences in efficiency; that is, are the Europeans just doing a better job than Americans are of supplying the same basic transportation services? In other words, should we be trying to emulate the European model? Second, to the extent

[1] Data obtained from L. Schipper and N. Kiang, International Energy Studies, Lawrence Berkeley Laboratories, in advance of publication in Oak Ridge National Laboratory, *Transportation Energy Data Book*, ed. 14 (Oak Ridge, TN: forthcoming).

that energy use differences reflect differences in efficiency, would shifts in U.S. energy and transportation policy toward European norms--e.g., high taxes on fuels and vehicles, and zoning restrictions designed to maintain high residential densities—lead to significant reductions in U.S. energy consumption toward European levels?

These questions are sometimes answered in the affirmative without any analysis to back them up. For a number of reasons, the correct answer might be "no" or "not entirely," and these reasons must be thoroughly explored before a definitive answer is given. As an example, for the first question, the differences in energy use could represent in part differences between Europe and the United States in geography and demography or in the quality and quantity of transportation services each supplies to its residents. It is well known that levels of energy consumption in less-developed countries are well below those of the United States, but the reasons have everything to do with the level of services and nothing to do with efficiency (the efficiency of systems in less-developed countries is generally far less than that of the United States). As for the second question, matching policies may not yield matching results. The extensive transportation infrastructure of the United States may create a status quo that limits the shifts in energy consumption achievable with feasible policies. Also, some of the differences between the United States and Europe may be caused less by policy differences than by differences in history and culture, and so cannot be undone by policy. For example, most European cities are substantially older than U.S. cities, and built for foot and animal traffic rather than for automobiles. Their greater residential density and lower travel requirements are due *at least in part* to this history. In fact, some analysts claim that European transportation is moving inexorably toward the U.S. model, despite the great differences in policy.

This chapter addresses the questions raised above, drawing on the work of several researchers who have examined and compared U.S. and European energy use. In doing so, the differences between U.S. and European energy use today are addressed, and the trends examined; the latter examination adds a critical dimension to the discussion.

The analysis is preliminary and exploratory, not definitive. The very critical question of comparative mobility is not addressed. Even though Europeans use far less energy for travel, do they still enjoy mobility—measured not in miles or kilometers per year but in the ability to access recreational, social, cultural, and employment opportunities—at levels similar to those enjoyed by Americans? Although this question is at the core of a fair energy comparison, any quantitative analysis would be extremely subjective, and adequate data are lacking. Nor can the relative roles of governmental policies and other influences in shaping transportation energy use be distinguished clearly, because of the great complexity of the systems involved and the lack of "controls" in evaluating the effects of changes in policies.

In this brief examination, comparisons with various countries are made, because the sources consulted do not all use the same ones. However, all comparisons include West Germany, the United Kingdom, France, and Italy, which together account for a major share of European transportation demand and energy consumption.[2]

PASSENGER TRANSPORT ENERGY IN THE U.S. AND EUROPE TODAY

Table 3-1 presents some basic statistics comparing passenger transportation energy use values and indicators for five European countries and the United States. As noted above, U.S. per capita transportation energy consumption is far higher

[2] For example, among 11 European countries—Austria, Belgium, Denmark, Finland, France, West Germany, Italy, the Netherlands, Spain, Sweden, and the United Kingdom—France, West Germany, Italy, and the United Kingdom accounted for 78 percent of passenger vehicle travel in 1985, about 636 billion vehicle-miles out of a total of 819 billion miles. Source: J. Darmstadter and A. Jones, "1%-(~spects for Reduced CO_2 Emissions in Automotive Transport," Resources for the Future, ENR90-15, August 1990, table 6.

TABLE 3-1: United States–Europe Passenger Transportation Comparison, 1990

	Autos (per capita)	Gas price (1990$)	Auto fuel economy (mpg)[a] New[b]	Auto fuel economy (mpg)[a] Fleet, on-road	Passenger miles (per capita)	Energy use (10^6 Btu per capita)	Car share (percent of passenger-miles)	Air share (percent of passenger-miles)
United States	**0.598**	**1.04**	**25.3**	**18.6**	**13,500**	**54**	**86**	**10.2**
France	0.413	3.40	36.3	28.0	7,800	16	83	1.3[d]
Italy	0.430	4.27	34.3	31.5[c]	7,400	14	80	0.9
Sweden	0.419	3.34	28.5	23.7	7,800	21	80	3.1
United Kingdom	0.352	2.55	32.0	25.0[c]	7,000	19	87	0.8
West Germany	0.499	2.72	30.0	23.5	6,900	21	84	0.8

a Includes light trucks used for personal travel.
b U.S. Environmental Protection Agency test values or equivalent
c 1988 data
d Includes domestic flights only, so European values are artificially low

SOURCE Lawrence Berkeley Laboratory

than that in European countries-n average, about three times higher. As demonstrated by the table, differences in per capita travel account for the major share of the overall energy differences: Europeans travel a bit more than half as much (in distance) as Americans do each year, and this difference accounts for about one-half of the per capita difference in energy use. The remainder of the energy difference is accounted for by differences in the relative share of different modes of transportation, load factor, and vehicle efficiency. Americans travel somewhat more in private autos, and far more in energy-intensive airplanes, than do Europeans, who make far greater use of buses and trains. Mass transit has about a 15 percent modal share—measured as a percentage of *passenger-miles*-in Europe versus about 3 percent in the United States.[3] European automobile fleets are more efficient than the U.S. fleet, partly because Americans purchase large numbers of light trucks for personal travel, and partly because American automobiles are larger than their European counterparts.[4] These differences do yield important differences in the energy efficiency of U.S. and European travel—Americans use about 4,000 Btu/passenger-mile versus about 2,100 Btu/passenger-mile in France, 1,900 in Italy, 2,700 in Sweden and the United Kingdom, and 3,000 in West Germany.

One interesting and perhaps surprising conclusion that can be drawn from table 3-1 is that despite the huge disparities in total energy use, European travel is nearly as automobile-dominated as U.S. travel—in both regions, the great majority of passenger travel is by automobile. However, statistics for *total* travel mask somewhat the automobile's utter dominance in the United States for trips of a few hundred miles or less, where its share is in the middle 90s compared with the European auto share of about 80 percent.

Also, the statistics in table 3-1, which are exclusively in terms of total travel distance, mask the role of bicycling and walking in European travel. In urban settings, where the European cities' high densities place work, services, and recreational activities within close reach of residential areas, and where careful attention has been paid to nurturing these modes, bicycling and walking play an important role in total tripmaking. Table 3-2 presents somewhat dated but still revealing estimates of modal split for the United States, Canada, and Western Europe, with shares measured as a percentage of total *trips*.[5] Whereas bicycling and walking accounted for only 11.4 percent of U.S. urban trips in 1978, these modes typically accounted for 30 to 50 percent of urban trips in Western Europe around the same time. Presumably, many of these trips, if they were being made in U.S. cities, would be longer in distance and would be made by auto.

Further insight can be gained by focusing specifically on auto owners in the United States and Europe. U.S. and European auto owners are far

[3] L. Schipper and S. Meyers, with R. Howarth and R. Steiner, *Energy Efficiency and Human Activity: Past Trends, Future Prospects* (Cambridge, United Kingdom: Cambridge University Press, 1992).

[4] With the global market in automobiles, there are few technological differences in automobiles in Europe and the United States; efficiency differences are due primarily to differences in average size and power, with emissions, safety equipment, and luxury features (power accessories, four-wheel drive) playing a role as well. One exception is the important role of diesel engines in Europe.

[5] J. Pucher, " Urban Travel Behavior as the outcome of Public Policy: The Example of Modal-Split in Western Europe and North America, " *Journal of the American Planning Association*, autumn 1988, table 1. Data on total travel are difficult to obtain and are viewed with suspicion by some analysts (Lee Schipper, Lawrence Berkeley Laboratory, personal communication).

TABLE 3-2: Modal Share of Urban Passenger Transportation (percentage of total trips)

		Mode					
Country	Year	Auto	Public transport	Bicycle	Walking	Motorcycle + moped	Others_
United States	**1978**	**82.3**	**3.4**	**.7**	**10.7**	0.5	2.4
Austria	1983	385	128	85	312	37	53
Canada	1980	740	150	◄	110		- ►
Denmark	1981	420	140	200	210		30
France	1978	470	110	50	300	60	10
Great Britain	1978	450	190	40	290	20	10
Italy	1981	306	260	◄	434		●
Netherlands	1984	452	48	294	184	13	10
Sweden	1978	360	110	100	390	20	20
Switzerland	1980	382	198	98	290	13	19
West Germany	1978	476	114	96	303	09	11

SOURCE J Pucher Urban Travel Behavior as the Outcome of Public Policy The Example of Modal -Split in Western Europe and North America *American Planning Association Journal* autumn 1988

closer to each other than are U.S. and European citizens in general: European auto owners travel by auto 60 to 80 percent as much as Americans,[6] versus about 48 percent for all citizens.[7]

If the reasons for the substantial disparities between travel volumes and energy use in the United States and in Europe were fully understood, one could better identify policy prescriptions that might move U.S. transportation toward the European model. Unfortunately, there are too many interrelated variables to construct a precise model relating transportation outcomes to country conditions, and logic and qualitative examination of the data must suffice. For example, it seems clear that the disparity in gasoline prices must be a major factor in the different driving propensities of U.S. and European auto owners, but it is equally clear that other factors play an important role as well. Among these are differences in the physical system, for example, the amounts of parking space and roadway and the speeds possible on these roads. The United States has two to four times as much road per capita as Europe;[8] 80 percent more parking spaces per 1,000 workers than Europe:[9] and traffic speeds in major urban areas that average about 27 mph versus only about 19 mph for major European cities.[10] Thus, for urban driving, European drivers can go only 70 percent as far as American drivers in the same amount of time.

The reasons the United States has a more automobile-oriented physical system are complex. In part, this is due to the following:

- specific U.S. policy decisions to set up a dedicated gasoline sales tax for road construction (whereas the higher European taxes are earmarked largely for the general treasury) and to construct the Interstate Highway System;

[6] L. Schipper et al., "Fuel Prices, Automobile Fuel Economy, and Fuel Use for Land Travel: Preliminary Findings From an International Comparison," *Transportation Policy*, forthcoming.

[7] This is assuming all European citizens travel 50 percent as much as Americans, using an 83 percent auto share versus the U.S. 86 percent share.

[8] Pucher, op. cit., footnote 5, table 5, 1982 data.

[9] P.G. Newman and J.R. Kenworthy, *Cities and Automobile Dependence: A Sourcebook* (Aldershot, England: Gower Publishing Co., 1989).

[10] Ibid.

- a U.S. tax code that encourages single-family home ownership and suburban sprawl through mortgage interest deductions,[11] and that defines the provision of free employee parking as a deductible business expense (more than 80 percent of U.S. work parking is free, a major subsidy of automobile use[12]);
- a U.S. approach to zoning that often favors low-density development; and
- a failure to subsidize mass transit during the 1950s and 1960s, when U.S. transit ridership fell to less than half its pre-World War II level.[13]

As Pucher has pointed out, even the huge subsidies of the 1970s failed to substantially boost mass transit ridership, at least in part because most of the capital subsidies went toward building a few new and very expensive rapid rail systems that did little to boost nationwide transit growth.[14]

Another reason is the U.S. decision to keep taxes on gasoline very low in comparison with European levels. The availability of inexpensive fuel has promoted a rapid increase in auto use that has continually pushed expansion of the highway system, while providing little incentive to use mass transit and thus little incentive to expand transit services.

The auto orientation of most American cities also has quite a bit to do with simple timing:

Many American cities evolved in a twentieth-century, postautomotive period where a combination of abundant land, a new transport mode, and cheap fuels all pointed to unique patterns of living and transport. By contrast, the concentrated urban configuration of many European cities was firmly locked into place many years--if not centuries---earlier It seems no accident that those American cities---namely the older ones along the Eastern seaboard, like Boston, New York, and Philadelphia-which most closely resemble European cities are also the ones in which public transportation survives as an enduring tradition.[15]

The importance of timing in determining urban form ought not to be taken as absolute, however. As Pucher points out, many American cities were densely developed and massively dependent on mass transit during the early part of this century, and then underwent a loss in density and a shift to auto orientation and suburbanization that accelerated after 1945.[16] Further, some European cities (Rotterdam, Nuremburg, Frankfurt) were extensively rebuilt after World War II, and others have large sections that were incorporated into their urban areas and built up during the automobile era.

Two prominent differences between the U.S. and Europe that might affect travel are the marked differences in residential density characteristic of U.S. and European cities and the very large U.S. land mass. Intuitively, a large land mass may be thought to signal a likelihood of high travel rates; actually, however, the data for countries of different size seem not to bear this out.[17] On the other hand, high densities do appear to depress travel rates, probably because they allow potential destinations-cultural, recreational, employment,

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11 It is important to note here that the form of encouragement is less an actual *favoring* of single-family homes over other forms than the general lessening of costs for all housing, which then allows personal preferences for single-family housing to more easily outweigh cost considerations in housing decisions.

12 Pucher, op. cit, footnote 5.

13 Ibid.

14 Ibid.

15 J. Darmstadter et al., Resources for [he Future, *How Industrial Societies Use Energy: A Comparative Analysis* (Baltimore, MD: Johns Hopkins University Press, 1977).

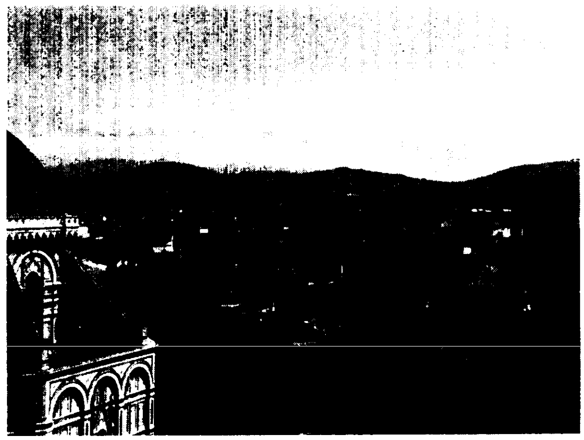
16 Pucher, op. cit., footnote 5.

17 Darmstadter et a]., op. Cit., footnote 15.

and so forth-to be within easy reach.[18] Also, as discussed in chapter 5, high residential densities are more easily served by public transportation, and the characteristically low U.S. urban densities (generally less than 8 per acre, compared to about 20 per acre in Europe[19]) make dependence on the auto virtually certain.

Another factor that may influence automobile use is the relative ease with which driving-age adults can gain access to a vehicle. The United States makes it far easier, in both a financial and an administrative sense, to gain such access. State governments levy only an average 5 percent tax on new autos (in 1982), versus from 14 percent (Germany) to 186 percent (Denmark) in Europe, and U.S. requirements for obtaining driver's licenses are minimal compared with the stringent (and expensive in terms of training) requirements throughout Europe.[20]

Differences in demographic characteristics between the United States and Europe are also important to differences in travel characteristics. As discussed in chapter 2, characteristics such as age distribution, number of women in the workforce, and so forth are important determinants of U.S. travel volumes. For example, high participation of women in the workforce has driven up U.S. passenger travel both by necessitating more work-trips and by giving more women financial access to automobiles. To the extent that women workforce participation may be higher in the United States than in Europe, this would contribute to the disparity in per capita travel distances. Although this topic is not pursued further here, it deserves a closer look.



MICHAEL GLUCK

High residential densities of European cities promote walking, bicycling, and transit use and reduce travel distances

Because of its continuing influx of immigrants, the United States has a lower proportion of its population over age 65 than do Western European countries.[21] This difference may explain at least a small part of the lower European annual person-miles of travel, because the over-65 population travels less than any other age group. For the United States, males over 65 take about 2.2 trips per day versus 3.5 for males ages 20 to 29 and 3.3 trips for males ages 30 to 39.[22]

Other factors that may contribute to Western Europe's lower tripmaking propensity are as follows:

- its greater degree of urbanization than the United States (in 1985,92 percent of the United Kingdom's population was urban, and most other Western European countries had more

[18] Ibid, Newman and Kenworthy, op. cit., footnote 9.

[19] Ibid.

[20] Pucher, op. cit., footnote 5. Since data on European rates of licensing have not been obtained, we cannot assert that the differences in licensing procedures and costs actually reduce these rates.

[21] U.S. Department of Transportation, *National Transportation Strategic Planning Study* (Washington, DC: March 1990), ch. 6.

[22] A.E. Pisarski, *Travel Behavior Issues in the 90's* (Washington, DC: Federal Highway Administration, July 1992), fig. 27.

than 85 percent of their populations in urban areas; in contrast, 74 percent of the U.S. population lived in urban areas[23]);

- its tendency to have a larger share of total country population in a single major city;[24] and
- the tendency of its populations to be less mobile in their decisions about where to live (many long-distance personal trips in the United States are made to visit distant family members). The importance of these factors deserves further examination.

As might be expected, the pattern of higher automobile orientation in the United States compared with Europe is not absolute. One anomaly in the pattern is the widespread European practice of awarding company cars to employees. About one-third of all new cars in West Germany and Sweden, for example, are company cars, as are more than half of the new cars in the United Kingdom.[25] Also, commuting costs are tax deductible in many European countries,[26] cutting drastically the real costs of driving. The existence in Europe of these market incentives in *favor* of auto travel may be part of the reason some transportation energy trends in Europe are beginning to converge with those in the United States.

For intercity travel, U.S. travelers use airplanes far more than Europeans do, and they use far less rail. There are a number of reasons for this: deliberate European policies to limit the number of flights and keep fares high; the more favorable geographic distribution of major European cities for rail travel (i.e., they tend to be a few hundred miles apart—far enough to discourage many drivers but short enough to allow high-speed rail to compete with air in door-to-door travel time); and European support for a network of efficient and high-speed rail systems.

TRENDS IN U.S. AND EUROPEAN PASSENGER TRANSPORT ENERGY

It is clear from the above discussion that, in many respects, the current European passenger transportation system is an attractive model for the United States to emulate *if reducing energy intensity is a high-value goal.* One potential counterargument to this conclusion is that European mobility may be lower than that in the United States. If it is, emulating the European model either will fail to reduce energy use as much as expected, if current levels of mobility are maintained, or will create an unacceptable decline in the average U.S. resident mobility and quality of life. This argument is not addressed here, except to note that it is unwise to assume that the lower level of European *travel* necessarily translates into a similarly lower level of European *mobility* (i.e., access to social, economic, recreational, and cultural opportunities). Another counterargument is that examining European transportation during one brief interval misses an important dynamic: Europe is rapidly becoming more like the United States in its auto orientation,[27] despite its high gasoline prices, dense cities, and superb transit, so that emulating its example will result in few energy savings. This thesis is examined here.

A comparison of changes in transportation energy use over time in the United States and Western Europe yields results that, at first glance, appear to support the proposition that the U.S. and European transportation systems are converging. Despite a lower population growth rate than in the United States, total European transport energy

[23] U.S. Department of Transportation, op. cit., footnote 21.

[24] Ibid.

[25] L. Schipper et al., "Fuel Prices, Automobile Fuel Economy, and Fuel Use for Land Travel: Preliminary Findings From an International Comparison," *Transport Policy*, vol. *1*, No. *1*, 1993.

[26] L. Schipper and G. Ericksson, "Taxation Policies Affecting Automobile" Characteristics and Use in Western Europe, Japan, and the United States," forthcoming, proceedings of the Asilomar Workshop on Sustainable Transportation, University of California-Davis, 1993.

[27] See, for example, C. Lave, "Cars and Demographics," *Access*, University of California at Berkeley, fall 1992.

growth over the past few decades has been much faster than U.S. growth: from 1973 to 1988, U.S. transportation energy grew by 13 percent, while Western Europe's grew by 55 percent.[28] A good portion of this differential, however, is due to the rapid improvement of U.S. automobile fuel economy during this period. European cars, in contrast, improved technologically but not in terms of fuel economy[29] because they became larger and more powerful. Also, Europe is starting from a much lower base of transportation energy use, so its higher growth rates are less impressive.

Because the primary reason for the U.S.-European differential transportation energy use is the difference in total travel per capita, rather than differences in mode or efficiency, the critical values for examining a potential U.S.-European convergence in per capita transportation energy consumption are changes in the travel per capita over time. Of the major European nations, most show growth rates of passenger travel per capita significantly higher than those in the United States. For example, for 1970 to 1987, passenger-miles per capita (p-m/c) grew by 53 percent in France, 61 percent in Italy, 41 percent in Sweden, 49 percent in the United Kingdom, and 40 percent in West Germany-a weighted average of 47 percent—versus 22 percent in the United States.[30] Even with per capita annual travel distances so much lower in Europe than in the United States, the difference in the European and U.S. rates of more than two to one is significant,

Focusing specifically on automobile travel reveals an even stronger gap in travel growth between the United States and Europe. From 1970 to 1987, per capita passenger travel by auto grew by 57 percent in France, 69 percent in Italy, 37 percent in Sweden, 67 percent in the United Kingdom, and 50 percent in West Germany-an average of 59 percent—versus only 16 percent in the United States.[31] What is happening here is that while auto travel is growing considerably more rapidly in Europe than in the United States (again, this is made less surprising by Europe's much lower starting level), U.S. air travel is growing so rapidly (over 7 percent per year for 1982 to 1989) that it is pulling up total U.S. passenger travel growth rates closer to Western European levels.

Much of the rapid growth in auto travel in Western Europe is due to high growth rates of vehicle ownership. In the 13 Northern and Western European nations,[32] per capita auto ownership increased 6.4 percent per year during the period 1965-75 and 3.2 percent per year during the 1975-87 period, whereas U.S. growth rates were 2.5 and 1.0 percent per year, respectively.[33]

Another trend that is important to the future U.S.-European transportation energy differential is the change in public transport (rail and bus, not counting school buses) usage. Between 1965 and

[28] Schipper and Meyers, op. cit., footnote 3.

[29] S.C. Davis and M.D. Morris, *Transportation Energy Data Book*, ed. 12, ORNL-6710 (Oak Ridge, TN: Oak Ridge National Laboratory, March 1992), table 1.7.

[30] L. Schipper et al., "Energy Use in Passenger Transport in OECD Countries: Changes Between 1970 and 1987," *Transportation, the International Journal*, April 1992.

[31] Ibid.

[32] Austria, Belgium, Denmark, Finland, France, West Germany, Ireland, Italy, Netherlands, Norway, Spain, Sweden, and the United Kingdom.

[33] J Darmstadter and A. Jones, Resources for the Future, "Prospects for Reduced CO_2 Emissions in Automotive Transport," ENR90-15, August 1990.

1985, U.S. passenger use of public transport fell from 4.7 to 1.2 percent of total passenger-miles,[34] whereas the public transport share of a sample of European nations fell from 26.6 to 17 percent.[35] In terms of actual passenger-miles, U.S. public transport ridership was fairly stable:

- Rail transit[36] ridership has fluctuated by about 20 percent over the past two decades, but was virtually identical in both 1970 and 1989 at 12.3 and 12.5 billion passenger-miles, respectively.[37] It has been rising over the past few years.
- Both transit and intercity bus ridership has been stable, with a combined total passenger-miles of 43.4 billion in 1970 and 44.8 billion in 1987.[38]

On the other hand, although it has decreased in modal share, European mass transit increased its ridership substantially during the same period. According to Lave,[39] during the 1965-87 period, bus and trolley travel in the European OECD nations increased by about 60 percent, and rail travel increased by more than 20 percent (although automobile travel increased by more than 160 percent in the same period, thus greatly increasing its modal share).

Thus, European mass transit, which started from a much higher per capita passenger base than the United States, continues to increase its ridership whereas U.S. mass transit has essentially stagnated (see chapter 2); the European lead in per capita ridership is growing. Although European transit may appear to be converging with the U.S. situation from the perspective of *modal share,* it appears extremely unlikely to "bottom out" at a share similar to that in the United States. Even at some theoretical "travel saturation" point, if it is ever reached and if there is no change in relative U.S.-European transportation policies, European transit should still have substantially higher per capita passenger-mile ridership than U.S. transit. In addition, total per capita travel should be substantially lower, because of the much higher density of European cities (see discussion on effects of urban form in chapter 5) and the higher costs of travel. Thus, the Office of Technology Assessment concludes that future mass transit operations in Europe will likely maintain a much higher modal share than in the United States, although the gap between the two will shrink somewhat.

For intercity travel, although rail retains a much higher modal share in Western Europe than in the United States, air has gained at the expense of rail. For example, in 1975, rail and air had equal shares of Western Europe's intercity passenger market; in 1986, rail share was half that of air.[40] Continuing growth of air travel in Europe would bring intercity energy efficiencies closer to those in the United States. However, the new and expanding high-speed rail network in Europe could change the trend toward air.

U.S. AND EUROPEAN FREIGHT TRANSPORT ENERGY USE

Freight transport is heavily influenced by the nature of countries' economies (i.e., what they produce, and where they produce and consume it), as well as their size and physical geography. Because the United States and Western Europe are quite dissimilar in size, geography, and production

34 Ibid The estimated share of public transportation varies from source to source. Note, for example, that the estimated 1989 share of bus and rail, not counting school bus rides, is 2.2 percent in S.C. Davis and M.D. Morris, op.cit., footnote 29, table 2.12, versus the 1.2 percent cited in Darmstadter.

35 Ibid. The nations included are Belgium, Denmark, Finland, France, West Germany, Italy, Norway, and the United Kingdom.

36 Not including commuter and intercity rail.

37 Davis and Morris, op. cit., footnote 29, table 6.13.

38 Ibid., table 3.30.

39 Lave, op. cit., footnote 27.

40 U.S. Department of Transportation, op. cit., footnote 21.

characteristics, their freight systems have many differences *over and above those that result from different policy choices.*

The United States has more than five times the land area of six Western European nations (the former West German y, United Kingdom, France, Italy, Sweden, and Norway) and produces large quantities (relative to total production) of bulk commodities that must be shipped long distances, both to internal markets and to coastal ports for export. As a result, the volume of freight hauling (measured in ton-miles) in the United States, relative to the size of its economy, is three times that of Western Europe.[41] Note, however, that this result leaves out "foreign" shipments between individual European countries and thus ignores shipments of longer lengths (and some that are quite short) that would be included in U.S. data.

U.S. shipping of bulk commodities over long distances allows heavy use of highly efficient pipeline, rail, and ship modes, as opposed to Europe's heavy dependence on trucking. In 1989, rail accounted for 32 percent of total U.S. shipping, or 40 percent of all nonpipelined shipping; ships for 26 percent of total, and 32 percent of nonpipelined shipping; and trucks for only 23 percent of total, and 28 percent of nonpipelined shipping.[42] Pipeline shipping itself accounted for 19 percent of the total. In sharp contrast, in 1988, trucks accounted for 63 percent of nonpipelined shipping in Western Europe, rail only 18 percent, and ships 19 percent.[43] And trucks' domination of European freight shipments is increasing over time, up from 54 percent in 1973, with rail absorbing the loss of modal share.[44] This increase is due to a combination of adoption in Europe (and the United States) of Japanese-style "just-in-time" delivery of materials and components for manufacturing, greater production of high-value-added products that require fast and flexible delivery, and growth of the European road network as auto usage grows.

The combination of the large differences in modes and some differences in the energy intensity of each mode leaves the United States with a (nonpipeline) freight energy intensity about 40 percent lower than Europe's[45]---due primarily to the relatively high intensity on a Btu per ton-mile basis of truck shipment. Although European trucking is less energy intensive than U.S. trucking, by about 15 percent, trucking in general is several times more energy intensive than other freight modes. For example, in the United States, not *counting differences in types of cargo carried,* trucking is almost nine times more energy intensive than shipping, and about eight times more intensive than railroads.[46]

CONCLUSIONS

The United States uses three to four times the transportation energy per capita used by Western European nations, primarily because Europeans travel less, choose more efficient modes, and maintain higher efficiencies in each of the modes. Several factors likely influence European travel rates, which average half as much as U.S. travel rates on a per capita basis:

- lower private vehicle ownership (influenced by very high vehicle purchase prices because of taxes, fewer roads, and other factors, but also affected by the later start of Europe auto "explosion");
- high fuel costs:
- much greater urban density and centralization;
- a better mix of residential and housing development than U.S. cities; and

[41] Schipper and Meyers, op. cit., footnote 3.

[42] Davis and Morris, op. cit., footnote 29, table 2.14.

[43] Schipper and Meyers, op. cit., footnote 3.

[44] Ibid.

[45] Based on data in table 4.4 in Schipper and Meyers, op. cit., footnote 3.

[46] Davis and Morris, op. cit., footnote 29, table 2.14.

- demographic factors such as the percentage of women in the workplace, age distribution, and family mobility.

Europeans choose mass transit more consistently than people in the United States both because European cities tend to have good systems and because lack of parking, high fuel costs. high residential density, and a road system that is somewhat sparse by U.S. standards make transit look more attractive. Finally, European automobiles are more efficient than U.S. autos, primarily because they are smaller and have fewer luxury features (e.g., air conditioning, power windows, automatic transmission).

Travel and energy trends in Europe show some convergence with conditions in the United States, and some analysts claim that Europeans will eventually catch up to Americans in their travel and energy use. They contend that automobile dominance is so powerful a force that it will tend to overwhelm differences in fuel costs and other factors between the United States and Europe. Certainly, part of the U.S.-European difference in auto travel reflects the fact that Europeans started their period of rapid growth in auto ownership later than the United States. There are strong reasons to believe, however, that European and U.S. "equilibrium points ''-conditions when travel and energy use remain stable over time—are not identical, and that Europeans will continue to travel less and use less energy than Americans, although the difference between the two systems certainly will narrow. One reason for this belief is that arguments that Europe simply is at an earlier stage than the United States in growth in auto dominance ignore the differences in travel and energy that appear among alternative conditions of urban development *within the United States.* As long as European cities are more dense than U.S. cities, and less "auto-oriented" (e.g., have fewer miles of roadway per capita), they will continue to have fewer trips made and a higher reliance on public transportation. Another reason is that European growth in auto ownership and auto travel in general is a less impressive refutation of the importance of high travel costs in affecting energy use than it appears. Namely, this is because some of this growth is associated with European *subsidy* of auto travel in the form of large-scale use of company cars and tax deductions for commuting, and Europe starts with a much lower base so higher growth rates translate into much lower absolute values of growth. Part of the difference in travel volumes and energy use is due to differences in demographic factors; it is not clear to what extent these factors might converge or diverge in the future.

To a large extent, what this argument boils down to is whether the differences in U.S. and European travel patterns are due more to differences in policy or differences in history, geography, income (both now and over the past few decades), and demographics. If policy is the dominant determinant, then shifting U.S. policy toward European-style high gasoline prices, land use controls, etc., could move the United States toward European-style transportation patterns. However, an important caveat is that much of our transportation and land use infrastructure is in place and mature, so that moving toward European norms will be slow. If factors other than policy are more important, massive policy shifts may be somewhat futile, and European travel patterns may also move gradually in the U.S. direction. Questions such as this can sometimes be resolved by statistical analysis, investigating which variables are more significant determinants of the energy outcomes under investigation. Pucher, for example, claims that relative gasoline and transit price differences among Nations-which are primarily determined by policy—are better statistical determinants of auto ownership and urban auto-transit modal shares than are differences in income .47

47 J Pucher .. Capitalism Socialism, and Urban Transportation: Policies and Travel Behavior in the East and West, " *American Planning Association Journal*. summer 1990.

However, Pucher readily admits that the combination of data problems, multicollinearity between variables, and a limited sample size makes statistical analysis suspect in this case.[48] Further, his analysis does not examine a host of other potentially significant variables that deserve close examination. Nevertheless, he is convinced that the data are strong enough to show that differences in transportation prices are indeed a strong determinant of travel behavior.

To sum up, it appears that if the United States were to make a concerted effort to copy the European model *but without some of its auto-subsidizing features,* it would stand a good chance of substantially improving overall travel efficiency and reducing travel volume from levels that would otherwise be achieved. But the United States is unlikely to match current European levels of energy use.

European freight transportation, unlike personal travel, is not more efficient than its U.S. counterpart, although its volume in ton-miles in proportion to total economic activity is much lower than in the United States. The types of goods transported and the physical conditions are sufficiently different from those in the United States that there seem to be few lessons easily extracted from a comparison of the two systems.

[48] Ibid.