Transportation in the Balance

A Comparative Analysis of Costs, User Revenues, and Subsidies for Highway, Air, and High Speed Rail Systems

by

Evelyn Chan
Adib Kanafani
Thomas Canetti

June 1997
UCTC 363

ACKNOWLEDGMENTS

This research was funded by the University of California Transportation Center. During the conduct of this research, we benefited from numerous discussions with the Center' affiliates. We particularly would like to acknowledge the comments and suggestions from David Gillen, Martin Wachs, and Mel Webber. In addition, we like to acknowledge the suggestions and assistance received from the Division of Aeronautics at the California State Department of Transportation, and from Leigh Fisher Associates. We also wish to acknowledge the valuable contribution of Susan Gardner in editing and producing this report.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

EXECUTIVE SUMMARY

The State of California will face an important transportation investment decision during the coming decade. With ever increasing demands for intercity travel in the entire corridor between Sacramento and San Diego, the State will need to consider the options available for expanding the capacity of the Corridor's transportation system. One major decision is whether to invest in a high speed rail system or whether the resources are better spent on expanding highway and air transportation capacity. Many studies, including the recent ITS study by Levinson et. al. (1996), suggest that high speed rail (HSR) is the costliest among the intercity modes. However, the question remains whether such a system can be justified on the basis of its lower external costs - primarily the social costs of air pollution and noise. A related question is whether the direct and indirect subsidies given to alternative modes, often in the form of uncompensated external costs, but also including unrecovered infrastructure costs, should be considered when making comparative evaluations. If these subsidies were taken into account, the relative advantage of each intercity mode would be affected. Given the presumed lower external costs of HSR, such a full-cost and revenue accounting would improve the relative feasibility of this technology.

This study is intended to shed some light on these questions by performing an accounting of the incidence and the magnitude of public sector costs and cost recovery for three intercity transportation modes: air, highway, and HSR. In particular, the nature and magnitude of user revenues from, and government disbursements to, each mode are considered for California. Given the absence of high speed rail in California, or the United States for that matter, the analysis of HSR is primarily based on various engineering construction and operating cost estimates, as well as ridership and revenue forecasts that have been prepared for a proposed HSR system in California..

Fiscal year 1993 is used as a representative recent year for analysis, and all costs and revenues are measured in 1993 dollars. For highway and air transportation we estimate public costs by a detailed accounting of funding by all levels of Government. We use 1993 passenger-kms. carried by each mode to derive average system costs and to allocate joint costs to the California Corridor. High Speed Rail costs are estimated on the bases of studies and projections made for the High Speed Rail Commission in California. The external costs of noise and air pollution are estimated on the basis of a recent study for the California Corridor by Levinson et. al. (1996).

A comparative analysis reveals several interesting observations about the balance sheets of the three modes. Table 1.0 shows the average costs, revenues and subsidies for each of the three modes in the California Corridor based on 1993 flow data and market share estimates.

Table 1.0 Estimates of Costs, Revenue and Subsidies for
Three Transportation Systems in the California Corridor

	Air	Highway	HSR
Internal Costs	1.91	1.34	15.16
External Costs	0.52	0.71	0.44
User Revenues	2.02	1.93	6.00
Subsidies:			
With No External Costs	-0.11	-0.61	9.16
With Base Estimates of External Costs	0.41	0.12	9.60
Doubled Estimate of External Costs	0.93	0.83	10.04
Ten Timed Estimate of External Costs	5.09	6.53	13.56

All costs are in ¢ per pass.km.

From these estimates it can be seen that without taking external costs into account, the air and highway transportation systems are revenue positive, and more than pay for themselves. Under these same assumptions on external costs, HSR does not pay for itself and is revenue negative. But with external costs added into the balance sheet, no mode is self-financing. Annual subsidies are required to operate any of these systems in the California Corridor. These subsidies are estimated at $303 million for air transportation, $791 million for highway transportation, and $952 million for high speed rail. When computed on a pass.-km. basis, and with the base estimates of external costs these subsidies amount to 0.41¢ for every passenger-kilometer traveled by air; 0.12¢ by highway; and 9.6¢ by high speed rail. A closer look at the effect of external costs can be seen in Table 1.0, in which the results are subjected to a sensitivity analysis on external costs. The need for such a sensitivity analysis is compelling, given the state of the art in external cost estimation. Our estimates are based on Levinson et. al. (1996) and appear to be similar to estimates made in other studies. Nonetheless, such estimates depend heavily on assumptions regarding the incidence of noise and air pollution, and the social costs of these environmental impacts. The sensitivity analysis shows the effect of doubling and of increasing ten-fold the estimates of external costs. It should be noted that HSR is not as sensitive to this variation in external costs as the other two modes. This is because these costs represent a relatively minor component of the total cost of this mode. The relative position of the three modes of transportation does shift as the severity of external costs is increased. With low estimates of the costs of noise and pollution the highway system requires the least subsidy per pass.-km. followed by air and then HSR. But as these costs are increased, the position of air transportation improves in relation to highway transportation. In all cases, HSR requires significantly larger subsidies than the other two modes. As seen in Table 1.0., with external costs increased ten-fold relative to the base estimate, HSR continues to require 2 to 2.5 times the subsidy per pass.-km. than highway or air transportation. In fact, an extrapolation of the numbers shown here suggests that external cost estimates will have to be 36 times our base estimates, for HSR and the highway mode to become equal in terms of subsidy per pass.-km.

It is interesting to consider what additional revenues would be needed for these modes of transportation to become revenue neutral under different assumptions of the magnitude of external costs. A simple calculation using the base estimates of external costs, suggests that the highway system can become revenue neutral with an additional gas tax of about 5¢ per gallon. This gas tax would increase to 36¢ per gallon if external costs are doubled, and to $2.90 per gallon if they are increased ten-fold. These levels of taxation are not surprising, as they are indeed to be found in many countries around the World. The case of air transportation can also be illustrated by calculating that the system can be revenue neutral with the base estimates of external costs by a surcharge of about $2.25 on each airline ticket in the California Corridor. This surcharge would rise to $5.11 if the costs are doubled, and $27.0 if they are increased ten-fold.

Implications of the results to the San Francisco-Los Angeles Corridor

It is often implied that, although HSR is by far the costliest of the intercity transportation modes in dollar cost per passenger kilometer traveled, some public subsidy is justified on the basis of lower social costs, as well as the direct and indirect subsidies currently given to other modes.

The results of this study begin to address the issue of what is a “reasonable” level of public subsidy for HSR, taking into account externalities such as noise and air pollution, and subsidies currently received by other modes. This analysis suggests that, if external costs are considered, no mode is fully self-financing. But the total annual subsidy required for HSR is three times as large as the subsidy required for air, and about 1.3 times as large as for highway transportation. In terms of unit costs and revenues, HSR requires a subsidy per pass.-km. 23 times that for air, and 87 times that for highway transportation. Even under extremely conservative assumptions regarding the estimation of the external costs of noise and air pollution, HSR will continue to require many times the subsidies needed by the other modes.

The implication is that the lower social costs of HSR are unlikely to outweigh its more expensive internal costs.

Ultimately, the decision of whether to build HSR with public funds will come down to political will and non-quantifiable measures, primarily in the area of external benefits, which are again, very hard to estimate. Just because the system will not be financially profitable does not necessarily mean that it should not be built for other reasons such as environmental quality and improved mobility. Probably the best argument so far for HSR lies in increased mobility and accessibility for Central Valley cities, but that would have to justify a fairly massive subsidy. It is often argued that the level of service for air transportation to and from the Central Valley is poor in that flights are expensive and infrequent, and that HSR would provide a much needed alternative mode of transport. An examination of the current situation reveals that intrastate air fares in the HSR corridor are about double the average air fare from San Francisco to Los Angeles, and the frequency is much lower. But, given the relatively low market demand in Central Valley cities, these conditions are not unexpected, nor are they particularly unreasonable. It is also important to note that long-haul fares from Central Valley cities to national or international destinations are comparable to similar flights originating from hub airports such as San Francisco. They are not generally twice as expensive. If improving mobility and air accessibility in the Central Valley is really important to the State, a California version of the FAA Essential Air Service program could be established to subsidize additional air service to the region, probably at a much lower cost than the subsidy required for HSR.

It is important to emphasize, however, that this study compares actual revenues and expenditures, which may not be the same as real costs needed to maintain a system. For the highway system, it is possible that optimal use of existing infrastructure would require significantly more funds for preventative maintenance than are currently being spent. Poor quality infrastructure, however, does not preclude utilization of the system. On the other hand, for aviation and HSR, the discrepancy between actual and desired expenditures may not be as great. Both systems cannot be operated unless the supporting infrastructure is maintained at a high standard, therefore actual expenditures are likely to be a good estimate of real costs. If the modes were compared on the basis of real costs, instead of actual expenditures, then the relative positions of transportation by air and HSR compared to the highway mode would probably be improved.

FINANCING TRANSPORTATION SYSTEMS

THE ROLE OF THE PUBLIC AND PRIVATE SECTORS

Traditionally, the federal government plays a large role in capital financing of major interstate transportation systems, such as the nation's airways and interstate highways, as well as mass transit and many smaller airports. The federal government also has a large role in the development and regulation of safety and performance standards. At the federal level, transportation revenues generally consist of trust fund collections from user charges such as fuel taxes, vehicles taxes, and air passenger ticket taxes. In addition to trust funds, general funds provide support to many systems.

State governments play a dominant role in the management of non-interstate highways that are financed mostly with state motor fuel taxes. Local governments are dominant in providing the facilities and services for local roads, mass transit, and airports. The private sector also shares some of these key local roles, such as the funding, operating, and sometimes owning of airports and water ports. Transportation revenues at the state and local levels include the funds generated by operating various modal facilities, such as tolls and rental charges levied on the users of the facilities. Local governments also often finance local road and street programs with special assessments and property taxes that may be commingled with other local revenue in a general fund.

The private sector plays an important role in operations. For example, automobiles and general aviation aircraft used for personal transportation are generally owned, operated, and maintained by private individuals. Also, the private sector is the key player in commercial air carrier operations and common-carrier truck transportation.

THE FULL-COST FRAMEWORK

In a recent study of the full cost of intercity transportation in California, Levinson et. al. (1996) estimate the full costs for three intercity modes of transportation: air, highway, and high speed rail. The estimates are based on econometric models using data available for the California corridor. For HSR, proposed alignments for the corridor are used to estimate construction, operation, and maintenance costs, supplemented by French data on TGV operations.

The results are summarized in Table 1.1, which illustrates the components of total cost included in the study. When applied to a corridor connecting the San Francisco Bay Area with the Los Angeles Basin, it is found that on the basis of full costs (public and private), air transportation, at $0.13 per passenger kilometer ($/pkt) is significantly less costly than the other two modes. High speed rail and highway transportation display similar average full costs, with rail costing $0.24/pkt and highway costing $0.23/pkt. The Levinson et. al. study also shows that rail is less costly in terms of social or external costs, but is more costly in terms of internal costs. Figure 1.1 illustrates these comparisons.

Table 1.1: Unit Estimates of the Full-Cost of Transportation by Mode

($/pkt)

Cost Category	Air System	Highways	High Speed Rail
Infrastructure : Construction and Maintenance	$0.0182	$0.0120	$0.1290
Carrier : Capital Cost	$0.0606	$0.0000	$0.0100
Carrier : Operating Cost	$0.0340	$0.0000	$0.0500
External : Accidents	$0.0004	$0.0200	$0.0000
External : Congestion	$0.0017	$0.0046	$0.0000
External : Noise	$0.0043	$0.0040	$0.0043
External : Pollution	$0.0009	$0.0031	$0.0000
User : Fixed + Variable	$0.0000	$0.0860	$0.0000
User : Time	$0.0114	$0.1000	$0.0440
TOTAL	$0.1315	$0.2297	$0.2373

Source: Levinson et al.(1996)

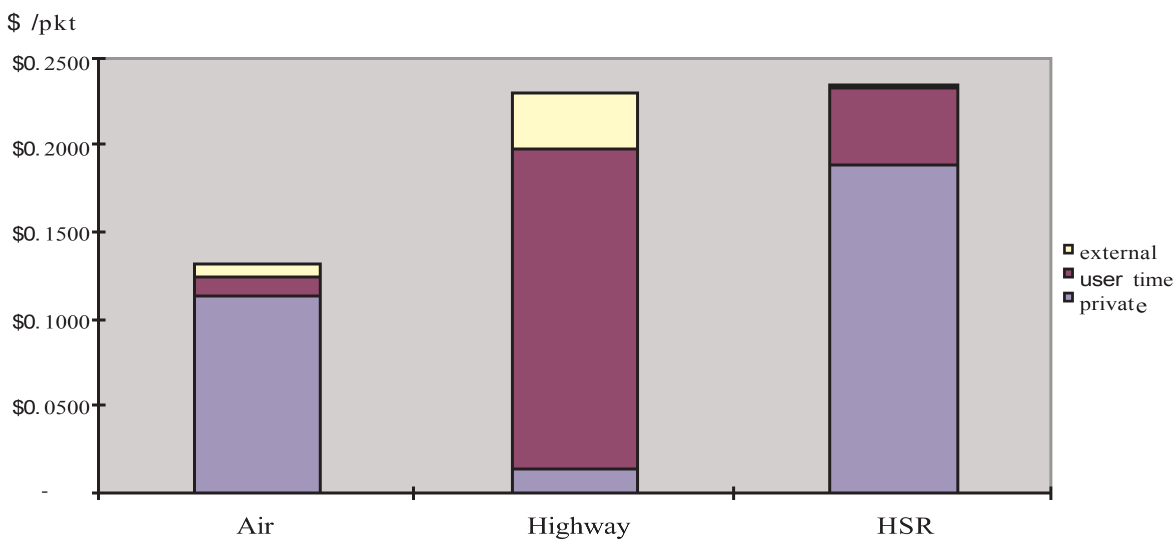


Figure1.1: Full-Cost Comparison

The full-cost models developed in the study can answer questions such as:

- Which mode is more costly when all resources are fully priced?;
- What are the sources of cost differences between modes?; and
- How do full costs change as the usage and/or size of the mode changes?

Full-cost models cannot, however, answer the question of what proportion of costs are being recovered internally through pricing and user charges.

Methodology

As a complement to the full-cost study, this study undertakes an accounting of the incidence of public sector costs and cost recovery for air, highway, and high speed rail. In particular, the nature and magnitude of user revenues from, and disbursements to, each mode are considered in the case of California. A "coverage ratio", defined as the ratio of total user revenues to total public costs, is determined for each modal system. A coverage ratio of 1.0 or greater indicates that a mode is self-financing. Conversely, a coverage ratio significantly less than 1.0 indicates that a mode receives substantial public subsidies.

For this endeavor, one requires a credible accounting of the subsidies given to each mode of intercity transportation at all levels of government. Direct and hidden subsidies can arise in a number of ways. Some examples include:

- ♦ Infrastructure and Operational Costs. Government may provide infrastructure and provide operating assistance to a mode free of charge, or at less than full recovery. Such subsidies are direct and generally appear in the budgets of the government and the respective mode.

- ♦ Special Financial Assistance. Special financial assistance can include tax exemptions, below market financing, and/or loan guarantees which lower the effective cost of raising capital. They are a source of hidden subsidies.

- External Costs. Uncharged damage to the environment caused by transportation is the equivalent of a subsidy, albeit also a hidden one. Environmental costs are probably higher in the case of highway transportation than air or HSR, but the opportunities to recover some of these social costs may also be higher. The external costs of accidents are often not fully recovered, even after accounting for insurance costs, and represent a subsidy to their respective modes.

Table 1.2 displays some of the ways of financing transportation systems, including user revenues, direct subsidies, and hidden subsidies, in an attempt to group and classify them. "Transportation-Related Revenues" are user revenues, i.e. revenues collected from those who use and directly benefit from transportation systems, mostly through special taxes or user fees. "Direct Subsidies" correspond to an allocation of a certain amount of general revenues to transportation systems. These subsidies are clearly defined, and can generally be justified on the basis of general interest. For instance, all the residents of a city benefit from roads, even non-drivers, as roads are needed by trucks, for example, to deliver products to stores. It is therefore appropriate that a portion of property taxes collected be used to finance roads. Finally, "Hidden Subsidies" are subsidies resulting not from a government allocation, but from special financial assistance such as tax-exempt financing or nonpayment of social costs.

It is often implied that, although HSR is the costliest of the intercity modes, some level of public subsidy is justified on the basis of lower social costs, as well as direct and indirect subsidies currently given to other modes. By undertaking an accounting of public sector costs and cost recovery for the three intercity modes: air, highway, and HSR, this paper addresses the issue of what is a "reasonable" level of public subsidy for HSR.

A Quantitative Caveat

Full-cost analysis is inherently subjective. It is also generally imprecise due to data limitations, the level of modeling performed, and the presence of many non-quantifiable factors. The cost and cost recovery estimates developed in this paper should be viewed with these quantitative caveats in mind. Yet, despite the limitations of a full-cost framework, valuable insights can still be gained regarding the general magnitude of public sector involvement in various transportation systems and the relative position of different modes when comparing costs, revenues, and cost recovery.

Table 1. Potential Financing Sources for Transportation Systems

Mode	Transportation-Related Revenues	Direct Subsidies	Hidden Subsidies
Highway	Tolls for road/bridge	General Obligation bonds	Cost of administration
	Driver's license fees	Land grants	Below market financing
	Impact fees	Loan guarantees	External costs absorbed by community
	Motor vehicle fuel taxes	Local taxes (property, sales, payroll)	Interest forgone on capital invested
	Parking fees	Locally sponsored road development	Tax exemptions/abatements
	Private roadway financing	Traffic-related police services	Tax-exempt financing
	Revenue-backed bonds	Medical services to accident victims	Taxes/fees not indexed to inflation
	Special assessment districts	Local traffic control services	
	Congestion tolls		
	Vehicle registration fees		
	Weight-distance taxes (trucks)		
Air	Airport concession revenues	Air traffic control (ATC) system	Cost of administration
	Airport landing fees	Airport fire and rescue services	Below market financing
	Airport terminal rentals	General Obligation bonds	External costs absorbed by community
	Passenger ticket taxes	Land grants	Interest forgone on capital invested
	Freight and Waybill Tax	Loan guarantees	Tax exemptions/abatements
	Revenue-backed bonds	Local taxes (property, sales, payroll)	Tax-exempt financing
	Gas/jet fuel taxes	Locally sponsored airport development	Taxes/fees not indexed to inflation
	Passenger Facility Charge (PFC)	Public services	
	Pilot registration fees		
	Private financing		
	Revenue-backed bonds		
	Special assessment/Value capture taxes		

AVIATION

THE FINANCING SYSTEM IN CALIFORNIA

The federal and local governments, as well as quasi-public entities such as airport authorities, have significant roles in the construction, operation, and maintenance of the aviation system in California. The State role is rather small and limited mostly to spending for general aviation (GA).

The Federal Role

For this analysis, federal outlays consist of all expenditures by the Federal Aviation Administration (FAA), except for the cost of administering the FAA itself. They include costs for constructing, operating, and maintaining the national air traffic control (ATC) system; airport development; safety regulation; and research. User revenues come from the Airport and Airways Trust Fund (AATF) that is derived mostly from the domestic passenger ticket tax, but also includes revenues from the freight and waybill tax, the noncommercial fuel tax, and the international departure tax. A summary of the tax rates and total national receipts to the AATF for fiscal year 1993 is shown in Table 2.1. Any FAA (minus government administration) expenditures not financed from the AATF are considered direct subsidies to the aviation sector.

The current federal role in aviation can be traced to the Airport and Airway Development Act of 1970 and the Airport and Airway Improvement Act of 1982. The 1970 Act established the user-supported AATF to provide grants for airport planning, airport master plans, and state and regional airport systems plans. The 1982 Act authorized funds for noise compatibility planning and also divided the federal funding program into two parts: the Airport Improvement Program (AIP) for airport planning and development, and the Airway Improvement Program for air traffic control equipment, facilities, and operations; research engineering and development; and the regulation of safety standards. The 1982 Act also established three basic funding categories for airport planning and development:

- Enplanement funds constituting 50% of the total AIP, to be apportioned to primary commercial service airports based on the number of enplaned passengers and cargo activity;

- State apportionment funds constituting 12% of the total AIP, to be allocated among states for use at GA airports based on population and area; and
- Discretionary funds with set asides for reliever airports, noise compatibility programs, nonprimary commercial service airports, systems planning and, in a 1990 revision of the Act, military airports.

Table .1: Total National Receipts to the Airport and Airways Trust Fund, FY 93

Tax	Tax Rate	$ Million
Domestic Passenger Ticket Tax	10% of the value of tickets on domestic flights	4,472
Freight and Waybill Tax	6.25% of the value of air cargo shipments	255
International Departure Tax	$6 per ticket	223
Fuel Tax	Paid only by General Aviation $0.15/gal on Aviation Gasoline $0.175/gal on Jet Fuel	120
Total Receipts		**5,056**
Interests on AATF Balance		1,040
Transfer to general fund		-1,794
Total Receipts remaining on the AATF		4,301

Source: United States Budget, 1993.

Historically, federal funds have covered about 10% of larger airports', and about 80% of smaller airports' capital funding needs. In 1990, Passenger Facility Charges (PFCs) were authorized to help alleviate the shortfall in funding. PFCs are an additional ticket tax of $1 to $3 on enplaning passengers, with a maximum of $12 on each round trip. PFCs are assessed by airports and paid when a passenger purchases a ticket, and are therefore considered a local charge applied to local airport projects. Large and medium hub airports charging a PFC have their AIP entitlement reduced by 50% of any revenue collected from the PFC.

On a national level, the AATF funds the entire AIP program, and about 50% of the costs to operate and maintain air traffic facilities.[1] FAA expenditures for FY 1993 are displayed in Table 2.2. Approximately 30% of FAA funding, primarily for ATC operations, is derived from the U.S. General Treasury. As discussed in the next section, because of the presence in California of 2 major U.S. airports (Los Angeles and San Francisco), the coverage ratio may be different in the case when California is considered separately.

Table . : Federal Aviation Administration Expenditures

FY 1993
($ million)

Capital Account (financed with AATF)		Operations Account (51% financed with AATF)		Total
AIP	$ 1,931	ATC share of operations	$ 3,435	
ATC		Non-ATC share of op.	$ 1,057	
Facilities & Equipment	$ 2,166			
R&D	$ 212			
Total	$ 4,309	Total	$ 4,492	$ 8,801

The California State Role

The State of California has a relatively limited influence on the aviation sector, as it is described below. It should be noted that the state role in aviation varies greatly by state. Other states such as Virginia or Massachusetts, for example, play a much more active role in aviation.

The State of California, through the Department of Aeronautics at Caltrans, administers two financial assistance programs, the California Aid to Airports Program (CAAP) and the Airport Loan Program. The CAAP program consists of three sub-programs: the Annual Grant program, the Acquisition and Development Program, and the AIP Matching Grant program. The Loan program provides financial assistance in the form of loans, repayable over a period not to exceed 25 years. All publicly-owned airports are eligible for funds, and the interest rate is based on the most recent issue of California bonds sold prior to the

[1] ATC spending from the AATF is capped at 50% by Congress to ensure that AATF money is used for aviation capital investments, rather than operating expenses.

Table .3: California Aviation Funding Programs

FY 1994

California Aid to Airports Program		Airport Loan Program	Total State Funding
Annual Grant	Acquisition & Development	Loans	
$965,000	$2,573,930	$953,233	$4,492,163

issuance of a loan agreement. Table 2.3 summarizes recent expenditures for the two programs.

Of the elements of the CAAP, the Annual Grant program is available only to public-use, publicly-owned GA airports. An eligible airport is credited annually with a grant of $10,000 which may be used for both capital improvements and operations and maintenance costs. Acquisition and Development (A&D) grants fund projects from the Capital Improvement Plan that is required as part of the California Aviation System Plan. Although all types of airports are eligible for A&D moneys, the majority of funds have historically gone to GA airports, mostly for taxiway, ramp apron, and runway improvements, as shown in Figure 2.1. The AIP Matching Grant program assists public-use, publicly-owned GA and commercial

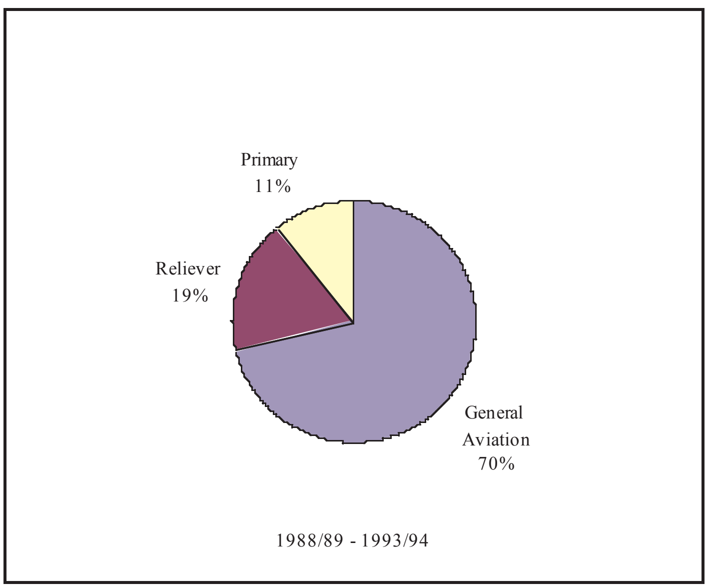


Figure 2.1: Distribution of California Acquisition & Development Grants

reliever airports in meeting the local match for AIP grants from the FAA.

The various state aviation programs are generally self-financing, funded by user taxes. The State Aeronautics Account receives about $7 million in GA fuel taxes each year. About 84% of that amount comes from taxes on aviation gasoline, and about 16% comes from taxes on aircraft jet fuel. Air carriers do not pay taxes on aviation gas or jet fuel. Table 2.4 displays the tax rates and revenues received from general aviation in FY 94. In addition, fuel is subject to sales taxes, and property taxes are assessed on GA and commercial aircraft. Property and sales tax revenues are directed towards state, county, and municipal general funds, and local school districts. Property and sales taxes are not considered user revenues, strictly speaking, because they apply to a broad range of items outside of transportation as well.

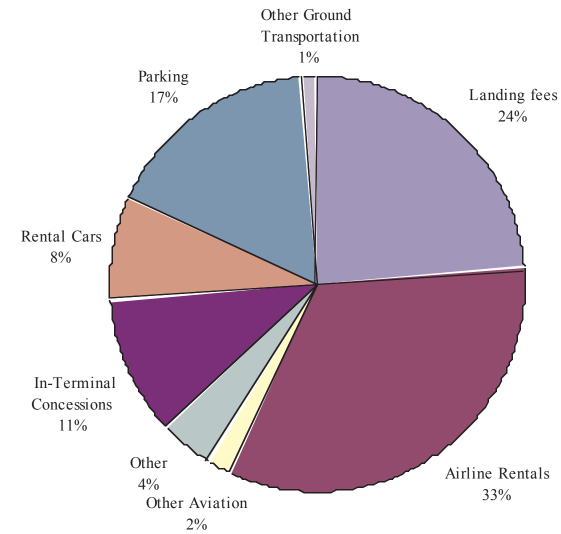
Table .4: Aviation User Taxes, State of California, FY 93

Tax	Rate	Receipts (million $)
General Aviation Gas Fuel Tax	$0.18 /gal	$6.5
General Aviation Jet Fuel Tax	$0.02 /gal	$1.3

The Local Role

The local government role varies greatly by airport. In addition to federal and state funds, airports rely on local funds, user fees, and concessions to fund their aviation activities. Outside of the AIP, nearly all expenditures for airport improvements and operations are undertaken by airports themselves. Since most airports are owned by local governments or quasi-public airport authorities established by local governments, the funds used are considered local funds.

User fees are a significant source of income at many airports. For most GA airports, leases for aircraft hangared at the airport are the primary source of revenue. At GA airports, fixed base operators also pay rent or a percentage of their gross income to the airport owners. Fixed base operators provide service such as charter flights, flight training, aircraft rental services, fueling, aircraft maintenance, and crop dusting. At commercial airports, airlines pay a landing fee, which generally varies by gross weight landed. Airlines also pay rent for terminal space and aircraft parking. Concession income from automobile rentals, food service, gift shops, vending, and parking are an important part of airport operating revenues, especially at commercial service facilities. Concession revenues account for about 40 % of total revenues at typical commercial service airports (see Figure 2.2).



Source: Leigh Fisher Associates

Figure 2.2: Distribution of Operating Revenues, Typical Large Hub U.S. Airport

Passenger Facility Charges (PFCs), as discussed earlier, are considered local funds, although they are subject to approval by the FAA. Airports can use PFCs for any airport projects that are eligible for federal funds. PFCs can also sometimes be used on non-AIP eligible projects such as environmental studies.

For large to medium size airports, bonds represent the most significant source of local airport funding. There are several different types of airport debt instruments:

- General airport revenue bonds (GARBS);
- General obligation or special assessment debt (G.O.);
- PFC-backed debt; and
- Special facility debt.

GARBs are by far the most common airport debt financing instrument. GARBs are secured by a first lien on net system revenues after payment of specified operating and maintenance costs. In general, the principal and interest on bond issues is paid with net airport system revenues regardless of type of instrument. The difference occurs in how the debt is "secured" in the event that system revenues do not meet debt service requirements. Appendix A contains a more detailed description of the various types of airport debt.

Airport bonds are generally backed by a public authority, often a municipality. The financial arrangement is a potential source of hidden subsidies (see Table 1.2). For example, the ability to raise funds through municipal bonds allows airports to borrow money at a below market rate because municipal bond investors are willing to accept a interest rate in return for stable, tax-free investments. Moreover, the municipal or state tax revenue foregone when a tax-exempt debt instrument is used represents a public subsidy, albeit a hidden one, to the aviation sector.

Some aviation finance experts estimate that loss of tax-exempt status would require airports to offer a 2% higher rate of return in order to successfully issue debt in a competitive financial market. A detailed analysis of hidden subsidies from special financial assistance for transportation, such as tax-exempt status for bonds, is beyond the scope of this study, but the amount of subsidy attributable to special financial assistance is not expected to be large relative to other sources.

Local general funds can be used to fund airport operations and capital development, although this is rarely the case in California. In fact, if anything, airports tend to supplement the general fund rather than take from it. Property taxes can be collected on the assessed value of aircraft. In California, the State Board of Equalization also requires counties to charge “possessory interest taxes” on the use of government-owned property such as airline terminals to all nongovernmental users permanently located at the airport. This tax is similar to property taxes but applies to private uses of government-owned property. The revenues collected go to cities, counties, and school districts, but are not required to be spent on aviation. In FY 94, county and municipal general funds, and local school districts in the state received approximately $70 million in tax revenue based on the assessed valuation of GA and air carrier aircraft. The contribution by the possessory interest tax was negligible. In terms of municipal services, airports often have financial arrangements with local governments to reimburse local agencies the cost of providing these services. For example, in 1993, the City of Los Angeles provided certain administrative and crash-rescue services to the Los Angeles Department of Airports at a cost of $8.7 million. The cost of these services was $8.7 million, all of which was charged to airport operating expenses.

Many public-private partnerships can exist between the owner of the airport and a private corporation to develop and operate airport capital projects, especially at commercial service airports. Frequently, airport facilities, such as dedicated terminals or hangars, are built and managed by airlines and nonairline private companies. Under various design-build-operate arrangements, private entities can build and then secure attractive long term leases for airport terminals and parking facilities, as well as collect rental and concession revenues. Upon expiration of such leases, the facilities revert to the airport owner. Public-private partnerships are important in financing airport infrastructure because they reduce the amount of airport authority and/or municipal funds that are tied up in projects that, in the case of terminal buildings, primarily benefit certain air carriers only or, in the case of parking facilities, could be better spent on airside and terminal improvements.

ESTIMATION OF COST INCIDENCE AND RECOVERY

Federal ATC costs attributable to California are estimated based on models developed by Golaszewski (1987) specifying total and marginal ATC costs by type of operation - instrument flight rule (IFR) departure, IFR overflight, air traffic control tower and terminal radar control area (TRACON) operations, and flight services provided. The Golaszewski models were developed using 1985 data aggregated at the national level, so the first step of this analysis scales the cost coefficients upwards to 1993 levels using the Consumer Price Index. The rescaled models are then applied to ATC operations attributable to California to estimate total ATC costs for California. A detailed explanation of the Golaszewski models and how they were adapted for use in this analysis is included as Appendix B.

Federal AIP spending for California airports is taken from the *FAA Statistical Handbook of Aviation* (1993). User revenues attributable to California and paid into the AATF were estimated with data from the Onboard T-3 and the O&D Plus databases and a methodology described in Appendix C. Table 2.7 shows the estimation of receipts to the Airport and Airways Trust Fund attributable to California. Receipts are based on numbers of enplanements and average airfares from the twenty-one busiest airports (by number of enplanements), which account for more than 99% of the total enplanements in California. Based on these assumptions, California generated about $729 million to the AATF in 1993. This amount represents 14.4% of the total receipts to the AATF in 1993. Moreover, the International Departure Tax (IDT) generated from California represents 27% of the total IDT generated throughout the whole country, largely because two of the top five US airports for international operations (Los Angeles and San Francisco International Airports) are in the State of California.

Table .7: California Receipts to AATF

FY 93 ($million)	
Domestic Passenger Ticket Tax	$615
Freight and Waybill Tax	$35
International Departure Tax	$61
Fuel Tax	$17
Total	$728

The Onboard T-100 and O&D Plus databases are used to estimate total passenger kilometers flown that are attributable to California, based on the number of originating passengers at California airports, and the distance flown. The methodology is also described in Appendix D. Table 2.8 displays passenger kilometers or air travel attributable to airports in California.

Table .8: Aviation Passenger Kilometers Attributable to California Airports

(all figures in millions)

	One-Way	Round-Trip
Flown over CA	22,343	36,521
Flown over U.S.	74,483	140,801

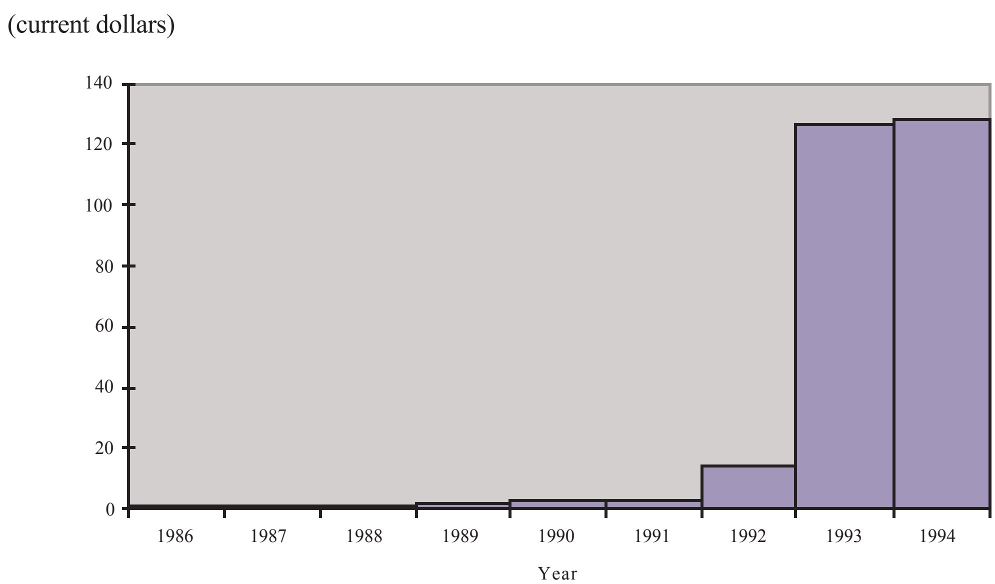
Data on state revenues from and disbursements to aviation come from the Caltrans Aeronautics Department. Data on local government finances are from the United States Bureau of Census. Since nearly all airports in California are self-financing through landing fees, leases agreements, and concessions[2], it is assumed that all reported local revenues come from user charges.

External costs due to aviation, such as noise and pollution costs, are taken from the full-cost study by Levinson et. al. (1996). It should be noted that Levinson et. al. estimate full costs without reference to existing levels of cost recovery. This study assumes, however, that since external costs are not well understood and are difficult to quantify, all external costs are unrecovered through user revenues. It is argued here, for example, that the cost of noise is (1) subjective and (2) difficult to measure accurately. The Levinson et. al. cost estimates, which are based on changes in land value, may therefore underestimate noise costs. So although airports currently spend significant amounts of money for noise mitigation, the full cost of noise estimated by Levinson et. al. (1996) is considered unrecovered by user revenues.

[2] Conversation with Mike Farmer, Caltrans Aeronautics Department. Only Lake Tahoe Airport is significantly subsidized by local general funds, a special case justified by the important role of the airport in bringing visitors to the tourist-oriented region.

The case of SFO is taken as an example to illustrate the difficulty in accurately estimating external noise costs. According to the airport's *Annual Report* (1994), SFO spent $127.2 million in 1993 and $128.9 million in 1994 for Home Noise Insulation, but only $25.3 million between 1986 and 1992, as shown in Figure 2.3. Mitigation spending is one measure of the cost of noise. Another conceivable approach is to calculate the cost of noise based on a cost of $0.0043 per pkt from Levinson et. al. (1996) and the number of pkt flown to and from SFO (22,050 million pkt in 1993, one way). This measure of noise costs yields $95 million for 1993.

The discrepancy between the two approaches can not be solved at this time, but can be explained, as the two calculations do not monetize the same effects. To emphasize again, the cost of noise and other externalities used in this study are taken from Levinson et. al. (1996) and are assumed to be completely unrecovered.



Source: San Francisco International Airport, Annual Reports

Figure .3: Annual Noise Mitigation Expenditures at SFO

Recognizing that the assumption that all the external costs of transportation are unrecovered is itself a subjective decision, this analysis also explores how cost recovery rates for the three intercity modes change with different assumptions about external costs. The "base case" in this study is the scenario in which all the external costs are based on Levinson et. al. (1996) and are considered unrecovered. Three other scenarios are also considered: (1) The case of no external costs, (2) the case in which external costs decrease 50% from the base case, and (3) the case in which external costs are twice as high as in the base case.

There are theoretical reasons why one might want to consider these different scenarios. If external costs are deemed by policy makers to be too subjective or difficult to meaningfully quantify, then perhaps transportation investment decisions ought to be made on the basis of direct capital and operating costs only, Case 1. Case 2 represents a reasonable modeling of the situation in which the Levinson et. al. cost estimates are assumed to be generally correct, but some of the costs are actually recovered, i.e. through spending for emissions controls and noise mitigation. Alternatively, Case 2 might also represent a situation in which external costs are believed to be overestimated by Levinson et. al. (1996). Case 3, on the other hand, represents a situation in which external costs are considered to have been underestimated by Levinson et. al. (1996). Such an underestimation of external costs is entirely possible, given the uncertainties in measurement and the level of modeling which can be applied to such costs.

Presentation of Results

Tables 2.9 and 2.10 show a comparison of revenues from, and disbursements to, the aviation sector in California, and for the case of Los Angeles International Airport (LAX) only. LAX is selected as a special case study to highlight the magnitude as well as the sources and uses of funds at a large commercial airport. Table 2.11 shows the results expressed as unit estimates ($/pkt).

Table 2.12 shows the cost recovery, or coverage ratios for the aviation system in California. All levels of government, as well as external effects, are included in the analysis. As explained in the previous section, sensitivity of the coverage ratio to variances in external costs is important to consider. External costs, being among the most difficult to quantify and monetize, are also some of the most uncertain costs. When external costs such as noise and pollution are considered, the aviation system in California recovers only about 63% of its costs through user revenues. It should be noted, however, that if external costs are not included in the analysis, the system is approximately self-financing. Table 2.13 shows how the coverage ratio changes under different scenarios regarding external costs.

Table .9: Aviation User Receipts and Expenditures for California

FY 93
($ millions)

User Revenues			Aviation Related Expenses		
Federal			Federal		
Airport and Airways Trust Fund	$729	[a]	Airport Improvement Program	$159	
			Air Traffic Control System	$610	[b]
Net Revenues	$729		Net Expenses	$769	
State			State		
GA Fuel Taxes	$8		Annual Grant Program	$1	
			Acquisition & Development	$3	
			Loan Program	$1	
Net Revenues	$8		Net Expenses	$5	
Local			Local		
Airport revenues	$777		Airport Expenses	$654	
Net Revenues	$777		Net Expenses	$654	
External			External		
			Noise	$322	[c]
			Pollution	$67	[c]
Net Revenues	$0	[d]	Net Expenses	$389	
NET, ALL UNITS OF GOVT	$1,514		NET, ALL UNITS OF GOVT	$1,817	

[a] AATF attributable to California based on methodology in Appendix C.
[b] ATC costs estimated using Golaszewski methodology.
Includes all aircraft types (air carrier, commuter, GA, military) and all services (ARTCC, ATCT, FSS, TRACON).
[c] External costs based on Levinson (1996) and pkt estimates derived in Appendix D.
Assumes 74,865 million pkt attributable to CA, and 25,900 million pkt attributable to LAX.
[d] Assumes that all external costs are unrecovered.

Table .10: User Receipts and Expenditure for Los Angeles International Airport

FY 93
($ millions)

User			Aviation Related		
Federal			Federal		
Airport and Airways Trust	$241	[a]	Airport Improvement	$20	
			Air Traffic Control	$136	[b]
Net	$241		Net	$156	
State			State		
GA Fuel Taxes	$0		Annual Grant	$0	
			Acquisition & Development	$0	
			Loan	$0	
Net	$0		Net	$0	
Local			Local		
Airport	$221		Airport	$160	
Net	$221	[d]	Net	$160	[d]
External			External		
			Noise	$111	[c]
			Pollution	$23	[c]
Net	$0	[e]	Net	$135	
NET, ALL UNITS OF GOVT	$462		NET, ALL UNITS OF GOVT	$451	

[a] AATF attributable to LAX based on methodology in Appendix
[b] ATC costs estimated using Golaszewski methodology.
Includes all aircraft types (air carrier, commuter, GA, military) and all services (ARTCC, ATCT, FSS,
[c] External costs based on Levinson (1996) and pkt estimates derived in Appendix
Assumes 74,865 million pkt attributable to CA, and 25,900 million pkt attributable to LAX.
[d] From City of Los Angeles Annual Financial Report, FY
[e] Assumes that all external costs are

Table .11: Unit Estimates of Public Aviation Costs and Revenues

Unit Estimates	($/pkt)
Costs	
Direct, federal	$0.0103
Direct, state and local	$0.0088
External, noise	$0.0043
External, pollution	$0.0009
Total costs	$0.0243
Revenues	
AATF	$0.0097
State Aeronautics Acct	$0.0001
Local	$0.0104
Total revenues	$0.0202

Table .1 : Ratio of Aviation User Revenues to System Costs

California System	Coverage Ratio
All units of govt + external	0.83
Total subsidy	$303
Federal costs and revenues only	0.95
State costs and revenues only	1.74
Local costs and revenues only	1.19

LAX Only	Coverage Ratio
All Units of Govt + External	1.03
Total Subsidy	($11)
Federal only	1.54
State only	n/a
Local only	1.38

Table .13: Sensitivity of Coverage Ratio to Variances in External Costs

Scenario	Coverage Ratio (all units of govt)
Base case	0.83
No external costs	1.06
External costs decrease 50%	0.93
External costs increase 50%	0.75
External costs increase 100%	0.69

HIGHWAY

THE FINANCING SYSTEM

The federal, state, and local governments all play significant roles in the construction, operation, and maintenance of the highway system in California. Although many local expenditures are for intra-city roads and streets, these local road systems serve as important feeders into the intercity highway system and cannot be ignored.

The Federal Role

The federal government, mostly via the Federal Highway Administration (FHWA) and the National Highway Traffic Safety Administration, plays a large, but somewhat indirect, role in highway construction and operations in California. In addition to general administrative expenses for FHWA and NHTSA, which are not included in this analysis, federal outlays for highways consist of expenditures for motor carrier safety; highway safety; demonstration projects; construction and improvements for the National Highway System and other urban and rural systems; bridge replacement and rehabilitation; R&D; right-of-way purchases; and safety rule making and enforcement.

The federal government's main role is to collect user revenues at the national level and subsequently redisburse funds back to state and local governments under the federal-aid highway program. The federal-aid highway program is financed from the proceeds of motor-fuel and other highway related excise taxes on tires, buses, tractors, and trailers which are deposited in the Highway Trust Fund (HTF). A summary of the tax rates and total national receipts to the HTF for fiscal year 1993 is shown below in Table 3.1.

Although federally assisted, the federal-aid highway program is actually a state-administered grant-in-aid program to distribute federal funds, subject to a state/local match[3], to states for the construction and improvement of urban and rural highway systems. Most funds are apportioned to states in accordance with formulas that give weight to population, area, mileage, relative needs, and the percent share of prior apportionment. On federal-aid projects, a state develops the plans, lets the contracts, and supervises the construction, subject to reimbursement of the federal share as work progresses. The roads remain under

[3] For most programs, fund must be matched by state or local governments on an 80% federal, 20% state/local basis.

administrative control of the state or local government responsible for their operation and maintenance. Unlike in the case of aviation and air traffic control, *direct* federal expenditures for the highway system are very small.

Table 3.1: Total National Receipts to the Highway Trust Fund

FY 1993
($ millions)

TAX	RATE (dollars)	HIGHWAY ACCOUNT	MASS TRANSIT ACCOUNT	TOTAL
Excise taxes				
Gasoline	$0.14	$10,712	$1,537	$12,249
Gasohol	$0.09	$416	$132	$548
Diesel	$0.20	$3,235	$321	$3,556
Special Motor fuels	$0.14	$25	$2	$27
Tires	(a)	$304		$304
Trucks and trailers	12%	$1,199		$1,199
Federal use tax	(b)	$630		$630
Fines and penalties		$14		$14
Total		$16,536	$1,992	$18,528
Deduct (refunds and tax credits)				
Diesel powered vehicle rebate		$8		$8
Diesel fuel used in buses		$5		$5
Diesel fuel-other		$123		$123
Special motor fuel		$12		$12
Gasohol		$31		$31
Gasoline used for aviation		$4		$4
Gasoline to make gasohol		$4		$4
Gasoline-other		$95		$95
Total		$282		$282
Transfers				
To Land and Water Conservation Fund		$1		$1
To Aquatic Resources Trust Fund		$207		$207
Total		$208		$208
Net excise taxes		$16,047	$1,992	$18,039
Interest		$817	$743	$1,560
Total Receipts		$16,864	$2,735	$19,599

(a)- $0.15/lb over 40 to 70 lbs; $4.50 plus $0.30/lb over 70 to 90 lbs; $10.50 plus $0.50/lb over 90 lbs.

(b)- Annual tax on motor vehicles: 55,000 to 75,000 lbs gross weight, $100 plus $22/1,000 lbs over 55,000 lbs; over 75,000 lbs, $550.

Source : Highway Statistics (1993)

The California State Role

State expenditures for highways and related public safety programs are provided by the Department of Transportation (Caltrans), California Transportation Commission, California Highway Patrol, Department of Motor Vehicles, and Office of Traffic Safety. In addition to administering the federal-aid highway program for the State of California, the state government has a role in the construction, operation, and management of the state highway system; highway planning and R&D; and highway law enforcement and safety, including state highway patrols, driver education and safety, vehicle inspection programs, and enforcement of vehicle size and weight limitations. The state government also provides for the sharing of state-collected highway user revenues with local governments in the form of direct grants-in-aid for local road and street purposes.

Revenue to support state highway activities is provided from HTF apportionment to California; some state general funds; bond proceeds; and state-imposed user revenues including state fuel taxes, motor vehicle registration and driver's license fees, road and crossing tolls, and truck taxes. Table 3.2 displays user taxes and revenues for California in FY93 . By investing surplus or unused highway funds, the state is often able to realize miscellaneous interest income on the purchase/sale of highway-related securities. State gross receipts taxes and ad valorem property taxes are not considered highway-user imposts because they are applied to a variety of commodities and activities not directly related to transportation as well.

The Local Role

The role and extent of local governments is diverse and variable. Local governments have the principle role in the construction and maintenance of county and municipal roads and streets. Under contractual agreements with the state, local governments may also be directly involved in construction and maintenance work for the state highway system or for federal-aid highway projects in California.

Table 3. : California State Highway User Tax Rates

and Revenues FY 1993

Tax	Tax Rate (per gallon)	Revenues ($ millions)
MOTOR FUEL TAX		
Gasoline tax	$0.17	$2,248
Diesel fuel	$0.17	*
Liquefied petroleum	$0.06	*
Gasohol	$0.17	$10
Total		$2,459
FEES		
Registration fees		$4,180
Other fees		$306
Total		$4,486
TOTAL		$6,945

* Total reflects revenues from subcategory, but individual amount unknown.

Source : Highway Statistics 1993

ESTIMATION OF COST INCIDENCE AND RECOVERY

All data for highway revenues and expenditures at all levels of government, except for external costs, are taken from *Highway Statistics* (1993), with some adjustments as explained in this section. As in the case of aviation, external costs due to noise and pollution are taken from the full-cost study by Levinson et. al. (1996) and are assumed to be completely unrecovered. Although the focus of this report is *intercity* transportation, all local government revenues and expenditures are considered because (1) local governments often perform work on and assist in the local match for state and federal-aid highway systems, and (2) local roads feed intercity traffic into the state and interstate highway systems in California and are an integral part of the intercity transportation system.

Regarding the Highway Trust Fund, since revenues cannot be directly attributed to highway users in each state, federal HTF revenues from California are estimated by FHWA based on data regarding fuel consumption and vehicle miles traveled. It is important to note that user receipts received for highways at the federal level as reported in *Highway Statistics* (1993) include only those funds which are deposited in the Highway Account of the Highway Trust Fund. These funds account for only approximately 75% of revenues actually collected. Other uses of the remaining 25% of federal user fee revenues include contributions to the Mass Transit Account of the Highway Trust Fund, and funds earmarked for the Leaking Underground Storage Tank (LUST) Fund and deficit reduction. For FY 93, a breakdown of the 25% ($433 M) diversion consists of:

Leaking Underground Storage Tank Fund	0.5%	(9 M)
Credit to Aquatic Resources Fund for off-road fuel	1.3%	(23 M)
Transfer to Mass Transit Account of HTF	9.5%	(165 M)
Funds Earmarked for Deficit Reduction	13.7%	(237 M)
	25 %	(433 M)

The LUST moneys represent an internalization of external costs that would not otherwise be accounted for in this study and, for our purposes, are properly omitted from net federal user revenues as reported in *Highway Statistics* (1993). The Aquatic Resources funds represent a credit for off-road fuel use and are therefore also omitted. The moneys to the Mass Transit Account should be added back to net highway user revenues since the Account funds mostly transit-related projects that make use of highways and roads. The funds earmarked for deficit reduction should also be credited back to net user revenues, since this portion of the diversion represents a subsidy *to the federal government from California highway users.* Crediting back the transit and deficit reduction funds yields an increase of $400 million of federal user fees attributable to California in FY 93.

At the state and local levels, only road-specific user charges are considered “user revenues” for comparison against highway expenditures. Local property and special assessment taxes are considered general fund revenues. Recognizing that local road expenditures often have benefits that extend to non users and the community at large, the coverage ratio as reported in this study should be regarded as a *lower bound.* Table 3.3 details revenues and expenditures for highways and roadways by level of governments.

Table 3.5: Highway Revenues and Expenditures for California

($ millions)

REVENUES					EXPENSES	
	User revenues		Other			
Federal						
	To HTF-Hwy Account				Capital outlays	$25
	User revenues	$1,300	Appropriation from General Fund	$99	Maintenance	$2
	Interest Income	$71	Other federal imposts	$31	Administration	$11
					Donations to State & Local	$1,496
	To HTF-Mass Transit Acct	$464			to State	$1,320
					to Local	$176
Total Federal		$1,835		$130		$1,534
State						
	State Highway User Tax	$2,945	Other Imposts + General Fund	$504	Capital outlays	$2,135
	Misc. Fees	$4,486			Maintenance+Traffic Service	$613
	Registration fees	$4,180			Administration + Hwy Police + Safety	$1,190
	Other	$306			Interest Expense	$5
	Road/Crossing Tolls	$132			Bond Retirement	$4,468
	Misc.	$80			Grant in Aid to Local Gov.	$1,607
	Bond Proceeds	$0				
	Payment from					
	Federal Gov.	$1,320				
	Local Gov.	$614				
Total State		$9,577		$504		$10,018
Local						
	Local User Revenues	$0	Appropriation from General Fund	$288	Capital outlays	$1,373
	Road/Crossing Tolls	$364	Property Tax	$157	Maintenance+Traffic Service	$1,356
	Misc.	$1,800	Other Local Imposts	$423	Administration + Hwy Police + Safety	$957
	Bond Proceeds.	$1,174			Interest Expense	$342
	Payment from				Bond Retirement	$367
	Federal Gov.	$176			Payment to State	$614
	State Gov.	$1,607				
Total Local		$5,121				$5,009

Source: Highway Statistics, 1993.

Table 3.3 gives a sense of the magnitude of funds flowing through the highway financing system at various levels of government, but because intergovernmental transfers of funds are shown as sources of both revenues and expenditures, some adjustments are necessary to avoid double counting and to understand total revenues from, and disbursements to, the highway system in California. For the purposes of this study, HTF revenues and expenditures attributable to California are considered state and local sources and uses of funds since, although federally-assisted, the federal-aid highway program is actually a state-administered program. Similarly, the local share of highway fuel taxes collected by the State of California and redistributed under various grant and revenue sharing agreements is considered a local source and use of funds.

RESULTS

Table 3.4 shows a comparison of revenues from, and disbursements to, the highway sector in California. Unit cost estimates are shown in Table 3.5. Table 3.6 displays the cost recovery, or coverage ratios for the highway system in California. All levels of government, as well as external effects, are included in the analysis. Unit cost estimates are based on an estimate of 428,917 million vehicle kilometers traveled in California in 1993 (*Highway Statistics*, 1993) and an average of 1.5 passengers per vehicle.

As in the case of aviation, the sensitivity of the coverage ratio to variances in external costs is important to keep in mind, since external costs are among the most difficult to quantify and monetize. Table 3.7 shows how the coverage ratio changes under different scenarios regarding external costs. In the base case in which external costs are based on Levinson et. al. and are assumed to be completely unrecovered, the coverage ratio is 0.94. This indicates that the highway system is generally self-financing. If external costs are actually twice as high, the coverage ratio decreases to 0.70. Conversely, if external costs are not considered, the ratio is improved to 1.44. The range is wide because, for highway transportation, external costs account for 35% of total system costs in the base case.

Table 3.6: Highway User Receipts and Disbursements in California

FY 1993
($ millions)

User Revenues			Highway and Road Expenses		
Federal			Federal		
HTF- Mass Transit Acct and non-hwy diversions	$400		Direct federal capital outlays and maint	$27	[a]
Interest Income from balance in HTF	$71				
Net Revenues	$471		Net Expenses	$27	
State			State		
State highway user tax less local share	$1,338		Capital outlays and maintenance	$2,748	
Road and crossing tolls	$132		Police, safety, admin, licensing	$1,190	
Miscellaneous income, including interest	$80		Interest expense	$5	[b]
Driver's license and vehicle registration fees	$4,486				
Pmt from fed govt for federal-aid hwy programs	$1,321	[c]			
Pmt from loc govt for local match in federal-aid hwy programs	$614				
Net Revenues	$7,971		Net Expenses	$3,943	
Local			Local		
Road and crossing tolls	$364		Capital outlays and maintenance	$2,729	
Miscellaneous income, including interest	$1,800		Police, safety, admin	$957	
Pmt from fed govt for federal-aid hwy programs	$176	[d]	Interest expense	$342	[b]
Local share of state user rev	$1,607		Payment to state	$614	
Net Revenues	$3,947		Net Expenses	$4,642	
External			External		
			Noise	$2,574	[f]
			Pollution	$1,994	[f]
Net Revenues	$0	[e]	Net Expenses	$4,568	
NET, ALL UNITS OF GOVT	$12,389	[g]	NET, ALL UNITS OF GOVT	$13,180	[h]

[a] Direct federal expenses only. Does not include federal-aid highway programs administered by state.
[b] Bond expense does not include repayment of principal. Only interest expenses remain as part of net expenses.
[c] Includes state share of approp from HTF.
[d] Includes local share of approp from HTF.
[e] Assumes that all external costs are unrecovered.
[f] Assumes 643,375 million pkt in CA. Based on VMT from Highway Statistics and assumption of 1.5 passengers per vehicle.
[g] Revenues from HTF are only counted once, not at both state/local and federal levels.
Revenues for state user revenues are counted only once, not at both state/local levels
[h] Expenditures for federal-aid hwy programs are only counted once, not at both state/local and federal levels.

Table 3.7: Unit Estimates of Public Highway Costs and Revenues

Unit Estimates	($/pkt)
Costs	
Direct, federal	$0.0000
Direct, state	$0.0061
Direct, local	$0.0072
External, noise	$0.0040
External, pollution	$0.0031
Total costs	$0.0205
Revenues	
HTF	$0.0031
State, non-HTF	$0.0103
Local, non-HTF	$0.0059
Total revenues	$0.0193

Table 3.8: Ratio of Highway User Revenue to System Costs

All Units of Govt + External	0.94
Total Subsidy	$791
Federal costs and revenues only	17.44
State costs and revenues only	2.02
Local costs and revenues only	0.85

Table 3.9: Sensitivity of Coverage Ratio to Variances in External Costs

Scenario	Coverage Ratio (all units of govt)
Base case	0.94
No external costs	1.44
External costs decrease 50%	1.14
External costs increase 50%	0.80
External costs increase 100%	0.70

HIGH SPEED RAIL

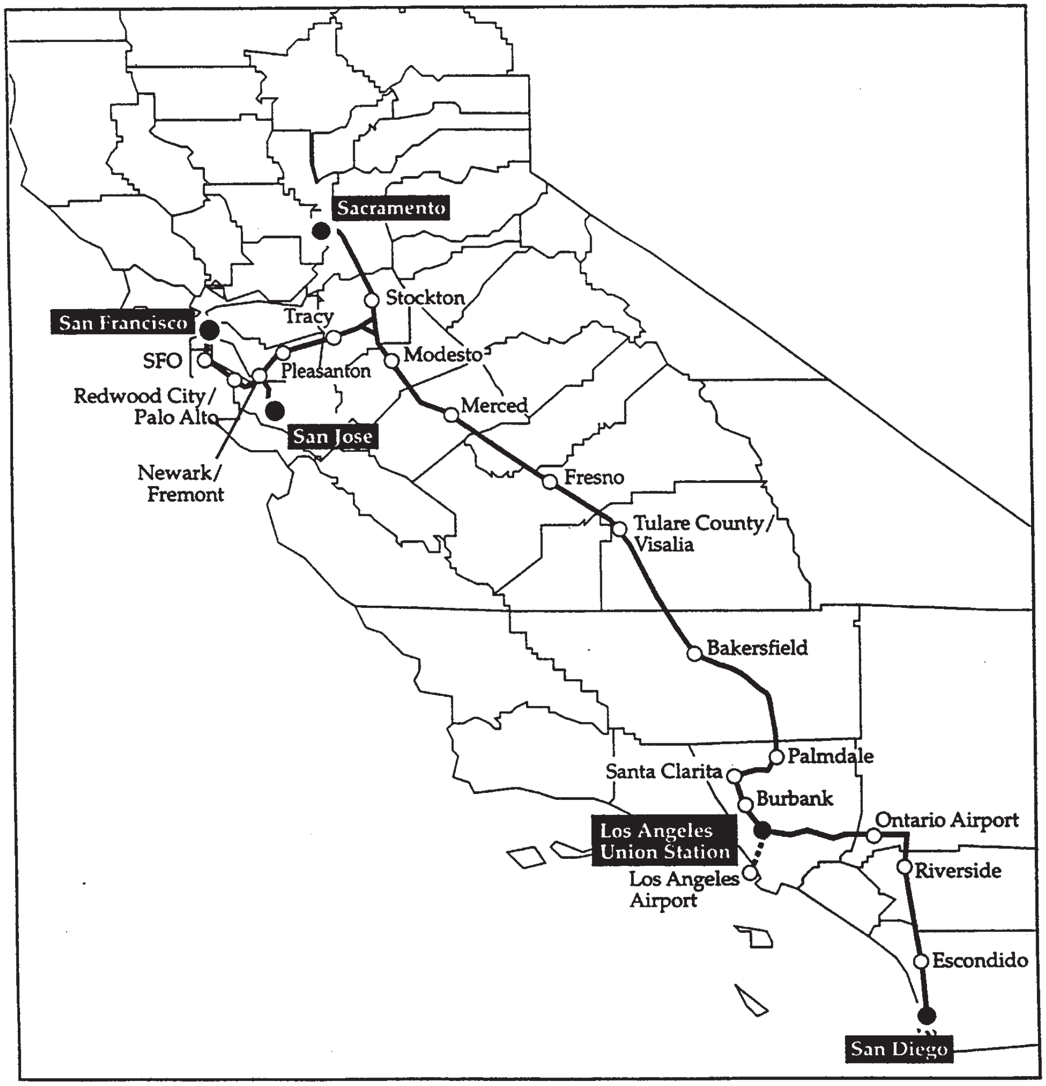
STATUS OF HIGH SPEED RAIL IN CALIFORNIA

Caltrans administers conventional passenger rail service on three routes: 1) the “San Diegan” between San Diego-Los Angeles-Santa Barbara-San Luis Obispo; 2) the “San Joaquins” between Bakersfield and Oakland; and 3) the “Capitols” between Roseville/Sacramento-Oakland-San Jose. The state contracts with Amtrak to provide this passenger rail service. There is currently no operational HSR service in California.

To investigate whether HSR might be feasible and advisable for California, the state established a nine-member Intercity High Speed Rail Commission (the Commission) to develop a framework for implementation of a HSR system in California[4]. The Commission was mandated to give first priority to developing a system connecting the San Francisco Bay Area with Los Angeles, and then consider extensions to San Diego and Sacramento.

In its final report, *High Speed Rail Summary Report and Action Plan* (1996), the Commission recommends a system to serve as the blueprint for HSR in California, recognizing that some flexibility needs to be maintained in the project design until the project is environmentally cleared and a construction contract is negotiated. The recommended system is almost 1,100 kilometers long and links California’s major population centers: Sacramento, the San Francisco Bay Area, the Central Valley, Los Angeles, and San Diego. Figure 4.1 shows a map of the recommended system. In terms of technology, the Commission focuses on systems capable of maximum operating speeds of at least 320 kph such as electric traction, steel-wheel-on-rail Very High Speed (VHS) and magnetic levitation (Maglev) technologies. Based upon current knowledge and experience, the Commission recommends VHS technology. VHS is the only technology, to this date, that has been proven in extensive revenue service. Table 4.1 details the characteristics, costs, and revenues for the proposed HSR system for California.

[4] Senate Concurrent Resolution 6 of 1993.



Source: California High Speed Rail Commission (1996)

Figure 4.1: Map of the Recommended System

Some important considerations regarding the proposed system should be noted:

- The primary purpose of the system is to serve intercity passenger travel;
- While VHS technology is capable of operating speeds over 320 kph, maximum speeds through densely developed urban areas will be limited to 150-250 kph;
- High speed trains must be separated from incompatible rail services, such as conventional freight operations. Sharing track with other passenger/commuter services may be possible.
- To attain the safety record of high-speed trains currently operating in other countries, the system must be entirely fenced and grade-separated.

Table 4.1: Characteristics of Proposed California HSR System (VHS)

Source: California HSR Commission (1996)

Capital Cost (1993 $million)		
Los Angeles - San Francisco / San Jose	$	10,600
Los Angeles- San Diego	$	5,400
Stockton - Sacramento	$	1,500
Vehicle Cost	$	900
Support Facilities	$	300
Total	$	18,700
Ridership (Year 2015 Passenger Trips, millions)		
(With Extensions)		19.8
System Revenue (Year 2015, 1993 $million)		
Passenger	$	574.0
Net Freight	$	18.6
Net Concession	$	2.2
Total	$	594.7
Annual O&M Costs (1993 $million)		
(With Extensions)	$	317.9
Length (kilometer)		
Los Angeles - San Francisco / San Jose		741
Los Angeles- San Diego		254
Stockton - Sacramento		93
Total		1088

The Intercity High Speed Rail Commission sunsetted in December 1996, but a new California High Speed Rail Authority was subsequently created to “direct the development and implementation of an intercity high speed rail system that is to be fully integrated with California’s existing transportation network”, based on the recommendations of the

Commission[5]. The new HSR Authority is responsible for the preparation of a comprehensive plan for the construction and operation of a high speed rail network for the state.

ESTIMATION OF COST INCIDENCE AND RECOVERY

The basic system with extensions is the scenario chosen for this study. Given the absence of high speed rail in California, the analysis is based on system cost and revenue estimates published in the *High-Speed Rail Summary Report and Action Plan* (1996). Under the direction of the Commission, the capital and operating cost estimates were prepared by Parsons Brinckerhoff. The ridership and revenue forecasts were prepared by Charles River Associates.

Some modifications and assumptions are necessary when using the Commission's cost and revenue estimates for this study. Since the Commission's estimates are presented in 1996 dollars, the Consumer Price Index is used to convert them to 1993 dollars in order to be able to make comparisons between the three intercity transportation modes. The Commission's costs and revenues estimates in 1993 dollars, therefore, are used in this study. For reference, HSR fares are based on a minimum $20 boarding charge, plus a constant fare per kilometer such that the Los Angeles to Bay Area HSR fare is equivalent to 70% of the average 1995 Los Angeles to Bay Area air fare. Predicted system costs, revenue, and ridership are shown earlier in Table 4.1.

The Commission's estimates are also assumed for annual operating and maintenance costs. These O&M costs reflect projected spending for:

- Train operations, including labor and supplies;
- Maintenance of equipment, including running maintenance and progressive overhauls for rolling stock;
- Maintenance of way, including maintenance and progressive replacement for track and all permanent structures;
- Station services, including sales and advertising costs, and operation of reservation systems; and
- General support, including corporate, administrative, and overhead costs.

Annual O&M costs are shown earlier in Table 4.1. Estimated annual capital costs in this analysis assume that all capital funds required, as reported by the Commission, are secured

[5] Senate Bill 1420 of 1996.

through bond financing. The annual capital cost is calculated as the annual payment required on a debt issue for the total funds needed, assuming an interest rate of 5%, a thirty year repayment period, and no reserve fund or capitalized interest requirements. Based on the total capital cost shown in Table 4.1, the annual cost given the above assumptions is $1,219 million (1993 dollars). It should be noted that this is an *extremely conservative* estimate of capital needs.

Passenger kilometers traveled (pkt) per year are based on the Commission's figure of 24.8 million train kilometers (15.4 million train miles) per year in the system with extensions, and an average of 400 passengers per train, based on figures for the French TGV system. These assumptions yield an estimated 9,918 million pkt per year. Unit costs estimates for capital and operating costs, as well as revenue per passenger kilometer traveled are obtained by dividing annual costs and revenues by passenger kilometers traveled.

As with the aviation and highway modes, external costs for HSR are taken from Levinson et. al. (1996). These cost estimates are conservative and should be regarded as a lower bound. Levinson et. al. (1996) assume that the social costs of HSR are restricted to noise. Since HSR rail systems are electrically powered, air pollution externalities are assumed to be internalized in the electric utility sector. Also, because of the safety records of existing HSR systems elsewhere, the risk of accidents is assumed to be zero. This does not mean that there is no safety cost, rather that it is incorporated in higher capital costs for system design. Noise cost is measured in terms of reduced property values. Assuming speeds of 320 kph (about 200 mph) and five trains per hour, the estimate of the external cost of HSR noise amounts to $0.0043/pkt. All external costs are assumed to be unrecovered in this analysis. Total annual costs and revenues for the proposed HSR in California are summarized in the Table 4.2.

Table 4. : Total Annual Costs and Revenues

	($ millions)
Capital cost per year	$1,219
O&M cost per year	$285
External cost per year	$43
Total cost per year	$1,547
Total revenue per year	$595

Sources: CA Intercity HSR Commission (1996) and Levinson et. al.(1996).

RESULTS

Table 4.3 shows pkt unit cost and revenue estimates for the proposed HSR system in California. Table 4.3 also shows the estimated coverage ratio. The cost recovery analysis is not broken down by level of government, since it is unclear what the actual political and operational environment for a statewide HSR system would be.

Unlike in the cases of the air and highway modes, coverage ratio is not particularly sensitive to external costs, since external costs are low, both in an absolute sense, and relative to capital and operating costs. Table 4.4 shows how the coverage ratio changes under different scenarios regarding external costs. It should be noted that if the system were required to cover only its operation and maintenance costs, as well as any external costs, then the coverage ratio would increase to 1.81.

Table 4.3: Unit Estimates for High Speed Rail Costs and Revenues

	($/pkt)
Capital cost	$0.1229
O&M cost	$0.0287
External costs	
Noise	$0.0043
Pollution	$0.0000
Total Costs	$0.1560
Total Revenue	$0.0600
Coverage Ratio	0.38

Table 4.4: Sensitivity of Coverage Ratio to Variances in External Costs

Scenario	Coverage Ratio
Base case	0.38
No external costs	0.40
External costs decrease 50%	0.39
External costs increase 50%	0.38
External costs increase 100%	0.37

COMPARATIVE ANALYSIS

This final section presents a comparative analysis of costs and cost recovery for the three intercity transportation modes: air highway, and high speed rail. Tables 5.1 and 5.2 and Figures 5.1 through 5.4 show the total and unit costs and revenues for the three systems, based on the modal analyses in previous sections of this report. It should be emphasized that "costs" refer to total public costs while "revenues" are defined as user revenues to the system. Table 5.1 shows costs and cost recovery including external costs. Table 5.2 shows the same information neglecting external costs.

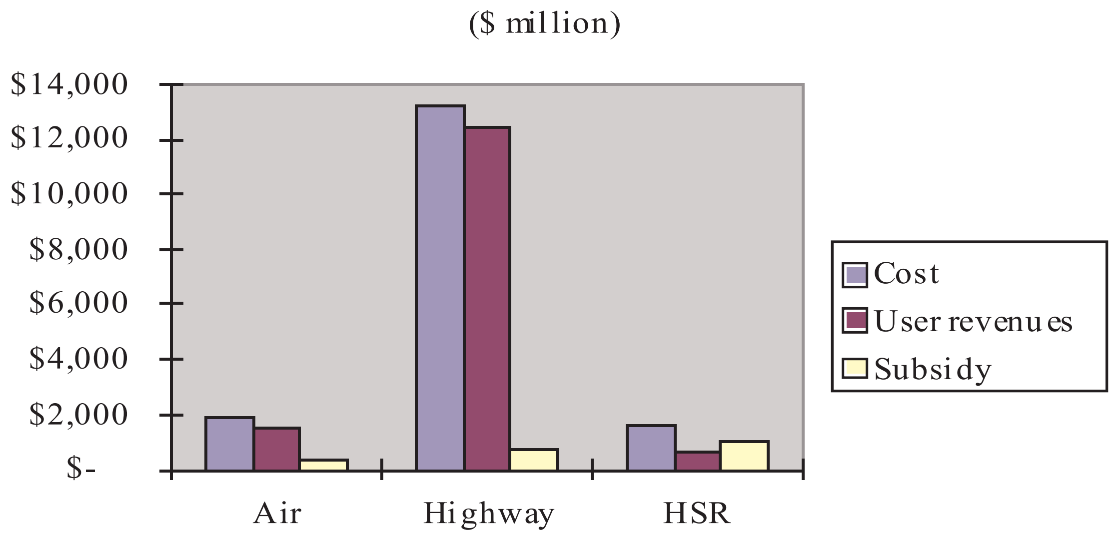


Figure 5.1: Total Costs and Revenues, All Levels of Government, Incl. External Costs

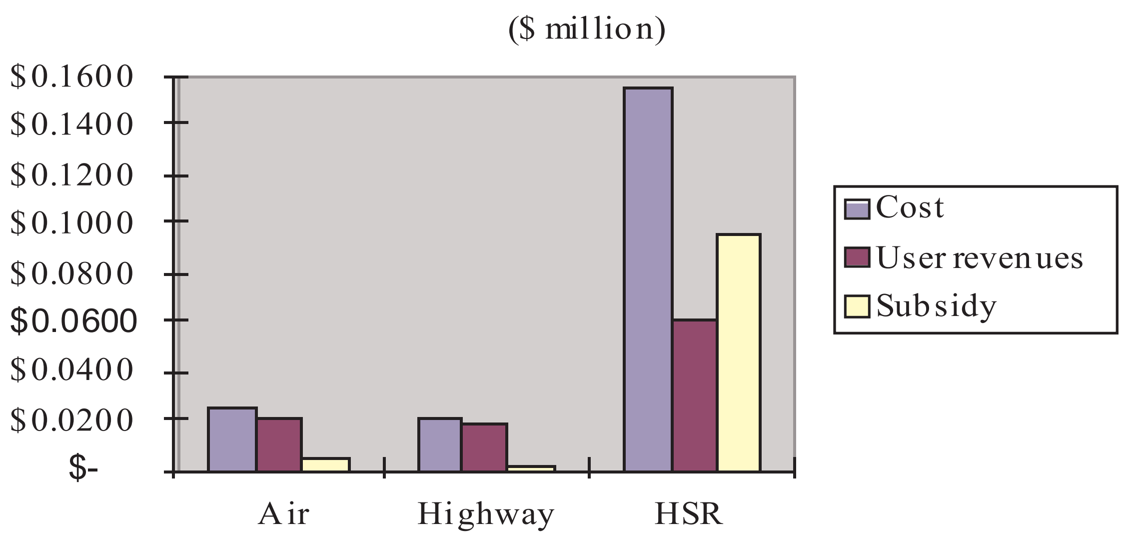


Figure 5. : Unit Costs and Revenues, All Levels of Government, Incl. External Costs

Table 5.1: Modal Comparison of Total and Unit Costs

All costs in millions of dollars

Costs and Revenues	Mode Air	Highway	HSR
Total Costs and Revenues			
Total cost per year	$1,817	$13,180	$1,547
Total user revenues per year	$1,514	$12,389	$595
Total subsidy per year	$303	$791	$952
Unit Costs and Revenues ($/pkt)			
Cost	$0.0243	$0.0205	$0.1560
Revenue	$0.0202	$0.0194	$0.0600
Subsidy	$0.0041	$0.0011	$0.0960
Coverage Ratio			
Base Case	0.83	0.94	0.38
No external costs	1.06	1.44	0.39
External costs decrease 50%	0.93	1.14	0.40
External costs increase 50%	0.75	0.80	0.38
External costs increase 100%	0.69	0.70	0.37

A comparative analysis reveals the relative and absolute scales of the three intercity modes. As shown in Table 5.1, if external costs are considered, no mode is fully self-financing. HSR, however, compares rather unfavorably, both in terms of total subsidy required, and subsidy per passenger kilometer of travel. It is important to emphasize that the unfavorable position of HSR transportation arises despite this study's extremely conservative estimate of capital needs and very optimistic ridership forecast. Recall that annual capital cost is calculated as the annual payment required on a debt issue for the total funds needed, assuming an interest rate of 5%, a thirty year repayment period, and no reserve fund or capitalized interest requirements. Most bond financing arrangements generally require funding of debt reserve equal to 1.1 times the annual debt payment, as well as the payment of interest every year during the construction period. Also, an interest rate of 5% is probably below market, and should be regarded as a lower bound.

Recall also that HSR revenues are based on a ridership estimate of 19.8 million (one-way) passengers per year in 2015, for the system with extensions, as shown in Table 4.1. For reference, the intrastate air market to and from San Francisco-Oakland-San Jose-Los Angeles-Ontario-John Wayne (Orange County)-San Diego-Sacramento-Burbank Airports encompassed approximately 11 million one-way air passengers in 1993. Assuming a modest growth rate of 3% per year, this corresponds to about 21 million passengers in 2015. For HSR to achieve its forecast ridership, the mode would have to capture a ridership comparable to the entire intrastate air market in California. Also for reference, total Amtrak ridership in 1990 was 22.2 million passengers nationwide, 11.2 of which constituted ridership in the heavily traveled Northeast Corridor. At a growth rate of 3% per year, about 17.5 million passengers can be expected in the Northeast Corridor in 2015, about 2 million fewer than the forecast ridership for the California corridor in the same year.

SUMMARY OF RESULTS

As seen in Table 5.1 and Figure 5.1, when comparing total costs and revenues, HSR has the lowest total system cost ($1,547 million per year), but it also has the lowest cost recovery and requires the largest subsidy ($952 million per year). Although air and HSR transportation have similar total system costs, the annual subsidy required for HSR in California is approximately three times as large as that for the air mode ($303 million). The total HSR subsidy is also approximately equal to the combined subsidy needed for both air and highway transportation in the state. Note that although the highway mode has annual system costs ($12,389 million) approximately seven times as large as those for air or HSR transportation, but it also collects a significant amount of user revenues, and the net subsidy required ($727 M) is on the same order of magnitude as for the other two modes.

When comparing unit costs and revenues, as shown in Figure 5.2, the subsidy per passenger kilometer traveled for HSR ($0.0960/pkt) is almost twenty times the combined subsidy required for both air and highway transportation ($0.0052/pkt). The air and highway modes have approximately the same unit costs and revenues per pkt. In contrast, HSR has a unit cost per pkt about seven times larger, but a dollar revenue per pkt only about three times as large, resulting in an relatively large subsidy per passenger kilometer of travel.

Table 5.2 and Figures 5.3 and 5.4 show the total and unit costs for the three modes if external costs are neglected. Sensitivity of the coverage ratio to changes in assumptions about external costs is important to keep in mind, since external costs, being among the most difficult to quantify and monetize, are also some of the most uncertain costs. The coverage ratio of 0.38 for HSR is not very sensitive to assumptions about external costs, largely because external costs are small both in an absolute sense and relative to capital and operating costs. Differences in external costs are more relevant for the air and highway modes.

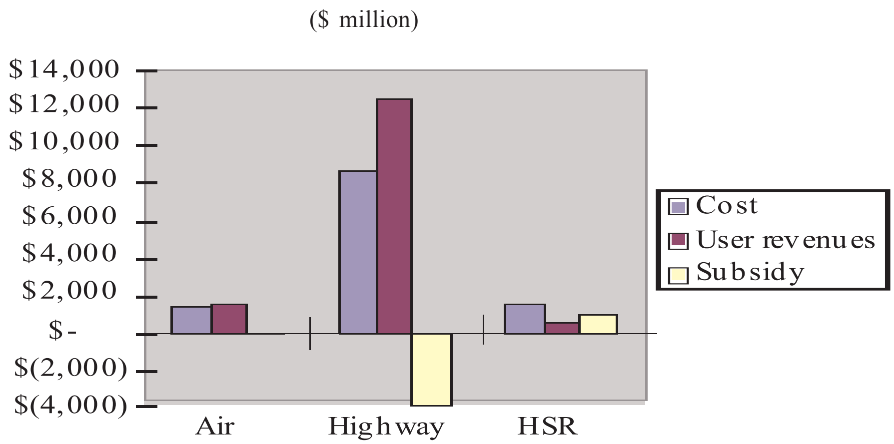


Figure 5.3: Total Costs and Revenues, All Levels of Government, No External Costs

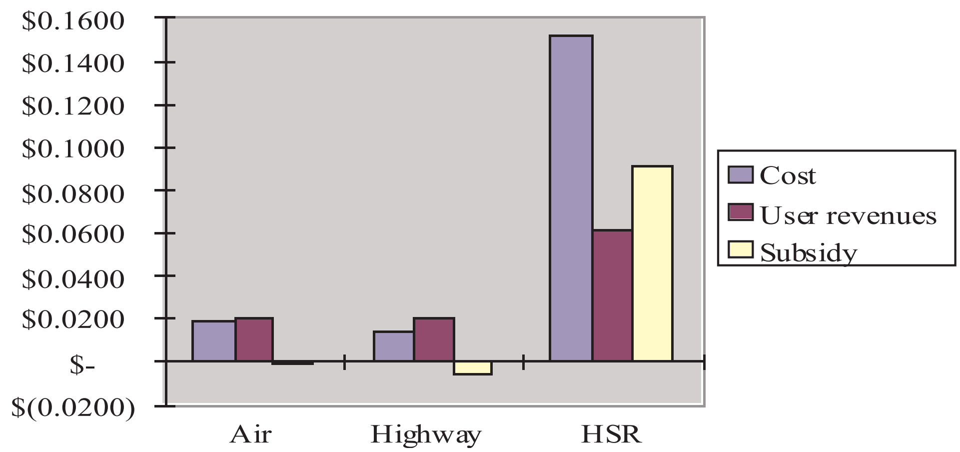


Figure 5.4: Unit Costs and Revenues, All Levels of Government, No External Costs

In the base case with external costs, the coverage ratio for the highway system in California is moderately higher than for air (0.94 vs. 0.83). But if external costs are actually twice as great as the estimates used in the base case, then the coverage ratios are approximately equal for the two modes (about 0.70), as shown in Table 5.1. This is because external costs account for 35% of total system costs for highway transportation in the base case, whereas they account for only 21% of total aviation system costs. If external costs were to double, the relative position of highway transportation declines due to the relatively larger impact of an increase in external costs. Conversely, if external costs are excluded, the relative position of the highway mode is improved. Without external costs, the coverage ratio is 1.45 for the highway system in California, and 1.06 for air, as shown in Table 5.2.

Relevance for the San Francisco-Los Angeles HSR Corridor

The California High Speed Rail Commission has concluded that a high speed rail passenger system in the extended corridor between Sacramento and San Diego is technically, environmentally, and economically feasible once constructed, and would be operationally self-sufficient. The Commission does acknowledge, however, that substantial public support is needed to finance construction of the system. Such required public support would be on the order of a $0.25 statewide sales tax, or a gas tax of 6¢ per gallon. The Commission asserts that there are numerous reasons why a HSR system connecting the state's major population centers deserves the widespread support of the people in California. These reasons include:

Table 5. : Modal Comparison of Total and Unit Cost, No External Costs

All costs in millions of dollars

	Mode		
Costs and Revenues	Air	Highway	HSR
Total cost per year	$1,428	$8,612	$1,504
Total user revenues per year	$1,514	$12,389	$595
Total subsidy per year	($86)	($3,777)	$909
Unit Costs and Revenues ($/pkt)			
Cost	$0.0191	$0.0134	$0.1516
Revenue	$0.0202	$0.0193	$0.0600
Subsidy	($0.0011)	($0.0059)	$0.0916
Coverage Ratio			
No external costs	1.06	1.44	0.40

- Economic benefits such as the generation of jobs, housing opportunities, and economic growth;
- Maintenance and improvement of environmental quality;
- Improving mobility and accessibility in areas not well served by existing modes;
- Diversity and providing an alternative to existing modes;
- Decreased need for expansion of constrained air and highway networks;
- Strengthening urban centers; and
- Image of the state as a desirable place to live and do business that is consistent with California's reputation as a center of high technology.

It is often implied that, although HSR is by far the costliest of the intercity transportation modes in dollar cost per passenger kilometer traveled, some public subsidy is justified on the basis of lower social costs, as well as the direct and indirect subsidies currently given to other modes. These justifications are grounded in a "level the playing field" type of argument.

The results of this study begin to address the issue of what is a "reasonable" level of public subsidy for HSR, taking into account externalities such as noise and air pollution, and subsidies currently received by other modes. This analysis suggests that, if external costs are considered, no mode is fully self-financing. But the annual subsidy required for HSR is three times as large as the subsidy required for air, and about 1.3 times as large as for highway transportation, even though HSR enjoys the lowest total annual cost. In terms of unit costs and revenues, HSR requires a subsidy per pass-km 23 times larger than for air, and 87 times larger than for highway transportation. Even if external costs are actually twice as high as the estimation used in this case and are assumed to be completely unrecovered, thus improving the relative position of HSR, the mode would still require a subsidy per pass-km about 11 times as large as for air, and about 12 times as large as for highway transportation.

It should be noted that the financial balance for high speed rail is compared with the actual public costs and revenues for air and highway transportation in California in 1993. High speed rail *is not* compared with hypothetical expanded air and highway systems that could develop in response to the absence of high speed rail. The comparisons made in this analysis are reasonable since, contrary to some public perception, the intercity air and highway markets in California are far from reaching capacity, and a massive expansion of infrastructure to meet new demand is unnecessary. If the demand warrants, air carriers can easily operate larger aircraft in the California corridor, thereby increasing aviation system capacity without significantly increasing airport congestion, the number of flights, or the number of airports required.

With respect to highway transportation, it is true that adequate roadway capacity is a significant concern in California. But most congestion is due to intracity and short-haul urban travel by road, not long-haul intercity travel which could be diverted to high speed rail. In theory, high speed rail could be also be used for regular work commutes from, for example, San Jose to San Francisco, it is unlikely to constitute an attractive commute option for many people, once fares and access/egress times are taken into consideration. Although system costs for highway transportation may very well increase in the future due to increased congestion and pollution, the potential for high speed rail to mitigate these costs is unclear.

Ultimately, the decision of whether to build HSR with public funds will come down to political will and non-quantifiable measures. It is unlikely that HSR will be a cost-effective mode of intercity transport for the California corridor, especially considering the well developed highway and air networks in the state, and the dispersed origins and final destinations for trips. Given the lack of an extensive underlying conventional rail system for local distribution to off-corridor cities, HSR in California will also be an isolated technology along the corridor, whereas the air and highway networks are connected to larger existing national and international networks.

But just because the system will not be financially profitable does not necessarily mean that it should not be built for other reasons such as environmental quality and improved mobility. Probably the best argument so far for HSR lies in increased mobility and accessibility for Central Valley cities, but that would have to justify a subsidy of almost one billion dollars. It is often argued that the level of service for air transportation to and from the Central Valley is poor in that flights are expensive and infrequent, and that HSR would provide a much needed alternative mode of transport. An examination of the current situation reveals that intrastate fares in the HSR corridor are about double the average air fare from San Francisco to Los Angeles. In terms of service, United Airlines/United Express/Shuttle by United alone provide six non-stops flights each day from San Francisco to Bakersfield and back, sixteen each-way between San Francisco and Fresno, and two each-way between San Francisco and Merced. Many more flights are available if United connecting service and service on other carriers are considered as well.

Given the relatively low market demand in Central Valley cities, these conditions are not unexpected, nor are they particularly unreasonable. It is also important to note that long-haul fares from Central Valley cities to national or international destinations are comparable to similar flights originating from hub airports such as San Francisco. They are not generally twice as expensive. If improving mobility and air accessibility in the Central Valley is really important to the state, a California version of the FAA Essential Air Service program could be established to subsidize additional air service to the region, probably at a much lower cost than the subsidy required for HSR.

It is important to emphasize, however, that this study compares actual revenues and expenditures, which may not be the same as real costs needed to maintain a system. For the highway system, it is possible that optimal use of existing infrastructure would require significantly more funds for preventative maintenance than are currently being spent. Poor quality infrastructure, however, does not preclude utilization of the system. On the other hand, for aviation and HSR, the discrepancy between actual and desired expenditures may not be as great. Both systems cannot be operated unless the supporting infrastructure is maintained at a high standard, therefore actual expenditures are likely to be a good estimate of real costs. If the modes were compared on the basis of real costs, instead of actual expenditures, then the relative positions of transportation by air and HSR compared to the highway mode would probably be improved.

CONCLUSION

Using a full-cost framework, this study has undertaken an accounting of the incidence of public sector costs and cost recovery for air, highway, and high speed rail transportation in California. This analysis suggests that, if external costs are considered, no mode is fully self-financing. The annual subsidy required for HSR, however, is significantly greater than for the other two intercity modes, measured both absolutely and in terms of dollars per passenger kilometer of travel. Just because a transportation system is not financially profitable does not mean that it should not be built, possibly for political, environmental, social, or economic reasons, but these results begin to address the issue of what is a “reasonable” level of public subsidy for HSR, especially in light of the well-developed air and highway networks in the state.

Clearly, there is ample room for improvement in this study. First, better methods for social cost estimation are needed. Recall that a sensitivity analysis on coverage ratio with respect to external costs is performed for different estimates of external costs ranging from no external costs to external costs twice as estimated by Levinson et. al. (1996). A factor of two range of uncertainty regarding external costs is much too large to yield extremely meaningful insights into the nature and magnitude of costs and cost recovery for any transportation system. Second, better and more disaggregate data would be invaluable. For example, with more disaggregate data, one could directly estimate of Airport and Airway Trust Fund revenues attributable to California, instead of “working backwards” to deduce this figure using data about total revenues nationwide, number of enplanements, and average airfares from California airports.

A logical follow-on effort to this study might consist of an economic analysis of costs and benefits for air, highway, and HSR transportation, as opposed to the strictly financial analysis of costs and revenues undertaken here. A financial analysis deals mostly with supply side variables, such as quantity of services provided, and the cost of production. Integration of a financial analysis into a demand-supply framework would allow evaluation of important economic concepts such as consumer surplus, producer surplus, and net social welfare.

APPENDICES

APPENDIX A :

SUMMARY OF AIRPORT DEBT FINANCING ISSUES[6]

Bond financing is a significant source of revenue for airports in the United States. In the 17 years between 1975 and 1992, there were 370 airport-related debt financing nationwide. These issues collectively raised $18.8 billion in funds for airport improvements. Also significantly, since most major airports in the United States are owned by local governments or quasi-public entities, most airport revenue bonds are considered tax-exempt.

There are several different types of airport debt instruments:

- General Airport Revenue bonds (GARBS);
- General Obligation or Special Assessment debt (G.O.);
- PFC-backed debt; and
- Special Facility debt.

The impact and feasibility of airport debt should be assessed in the context of a specific airport's markets, capital plans, and financial agreements with air carriers, but in general, the principal and interest on bond issues is paid with net airport system revenues regardless of type of instrument. The difference occurs in how the debt is "secured" in the event that system revenues do not meet debt service requirements.

GARBs are by far the most common airport debt financing instrument. GARBs are secured by a first lien on net system revenues after payment of specified operating and maintenance costs. Most GARBs include a rate covenant provision that net system revenues meet or exceed 125% of debt service requirements. [7]

G.O. debt may be backed by general funds such as sales taxes, property taxes, special assessment districts, or other non-system revenues. G.O. debt is not commonly used in airport finance because of the high revenue generating potential of airport systems. Also, GARBs tend to pay a higher rate of interest, making them more attractive to investors. Some examples of G.O./special assessment debt include:

- Minneapolis-St. Paul: Debt backed by taxing power of Airport Commission;
- Raleigh-Durham: Debt backed by taxing power of special district;
- Phoenix: Debt backed by sales and excise tax receipts; and
- Albuquerque: Debt backed by gross receipts taxes.

In all cases, despite the legal pledge of security from non-system sources, only net airport revenues have ever been used to pay debt service requirements. No G.O. backed airport district has ever levied a property tax specifically to fund airport debt.

PFC backed debt is backed by FAA-approved passenger facility charges. In general, PFC backed debt is not rated investment grade because of the problematic ability of a third party (FAA) to terminate bond security (PFCs) if an airport violates certain provisions with

---

[6]Source: *Moody's on Airports: The Fundamentals of Airport Debt*.

[7]Because most airports operate using a residual cost structure to determine revenue agreements with air carriers, annual debt service coverage always meets, but often may not exceed, the required rate covenant. The real revenue raising flexibility of an airport is defined by airport/air carrier agreements that are external to bond indenture, such as gate control issues, or the financial stability of dominant carriers at the airport.

respect to the collection and use of PFCs. **Special facility debt** is common in cases in which a special facility is built on behalf of a carrier who, in turn, directly secure the debt. For example, a new international terminal could be financed by the net revenues of the international terminal only.

APPENDIX B : COST OF AIR TRAFFIC CONTROL SERVICES

The cost of air traffic control (ATC) services is derived based on work by Golaszeswki (1987). Using econometric methods and data regarding the magnitude and total cost of ATC services provided in 1985, Golaszewski developed unit marginal and average cost estimates for different types of ATC services. The unit cost estimates vary by (a) type of ATC facility/service, and (b) classes of aircraft operations. Four types of facilities are considered:

Air Route Traffic Control Centers (ARTCCs);
Terminal Radar Control Areas (TRACONs);
Air Traffic Control Towers (ATCTs); and
Flight Service Stations (FSSs).

Four classes of aircraft operations are considered as well:

Air carrier;
Commuter;
General aviation; and
Military flights.

Golaszewski estimated his model using aggregate national data. This analysis assumes that the provision of ATC services in California involves the same general cost structure. His cost estimates, with some adjustments described below, are applied to the State of California to calculate the cost of ATC attributable to California in 1993. The special cases of Los Angeles International Airport and the Los Angeles Department of Airports (LADA) are considered as well.

Since Golaszewski's cost estimates are in 1985 dollars, they were first inflated to 1993 dollars (the study year) using the Consumer Price Index[8]. Also, when the original (1985-based) cost estimates are applied to actual 1985 data, predicted costs equal actual costs, as reported in the Budget of the United States. But the inflation adjusted estimates overpredict total cost in 1993, possibly because of economies of scale in the provision of ATC services. The inflated estimates, therefore, were further adjusted downwards using a scale factor of 0.958 so that total predicted costs equal actual costs for that year. Table B.1 shows the original Golaszewski unit costs, the costs inflated to 1993, and the subsequent downward-adjusted cost estimates.

The data regarding number and type of ATC services attributable to California are taken from *FAA Air Traffic Activity Statistics, FY 1993.* Tables B.2, B.3, and B.4 summarize the relevant ATC statistics for 1993. The figure for aircraft handled by ARTCCs assumes that all operations handled by the ARTCCs in Oakland and Los Angeles (the only two ARTCCs in California) are attributable to air travel to and from California. FSS data is only reported at the state and national level, therefore the share attributable to LAX/LADA is approximated by the state total weighted by their respective shares of airport operations in the state. Data on instrument and airport operations, which includes ATCT and TRACON operations, is provided at the airport level, and the state total reported by the FAA is simply the sum of operations by all airports in the state.

[8] All Items, All Urban Consumers

The adjusted costs estimates are applied to the 1993 ATC activity data to arrive at total cost of ATC services attributable to California in 1993, by type of aircraft and operation. The results are summarized in table B.5.

Table B.1: Unit Total Costs of ATC Service, by Type of Aircraft and Operation

Unit Total Costs of ATC Services ($93)

Facility Type	Service	Air Carrier ($93)	Commuter ($93)	General Av ($93)	Military ($93)
ARTCC	IFR Departure	$180.71	$177.35	$87.52	$188.21
	Overflight	$90.35	$88.66	$43.77	$94.11
TRACON	Operation	$83.02	$81.48	$11.93	$56.55
ATCT	Operation	$51.31	$11.84	$5.00	$19.66
FSS	Pilot Brief	$44.49	$43.67	$23.77	$30.31
	IFR Flight Plan	$44.49	$43.67	$23.77	$30.31
	VFR Flight Plan	$88.73	$87.08	$47.39	$60.43
	Air Contact	$25.10	$24.63	$13.40	$17.10

Source: Golaszewski (1987), inflated to $93 using CPI, All Items, All Urban Consumers.

Adjusted Unit Total Costs of ATC Services ($93) Used in Analysis

Facility Type	Service	Air Carrier	Commuter	General Av	Military
ARTCC	IFR Departure	$173.12	$169.90	$83.84	$180.31
	Overflight	$86.56	$84.94	$41.93	$90.16
TRACON	Operation	$79.53	$78.05	$11.42	$54.18
ATCT	Operation	$49.16	$11.35	$4.79	$18.83
FSS	Pilot Brief	$42.62	$41.84	$22.77	$29.04
	IFR Flight Plan	$42.62	$41.84	$22.77	$29.04
	VFR Flight Plan	$85.00	$83.42	$45.40	$57.89
	Air Contact	$24.05	$23.60	$12.84	$16.38

Source: Golaszewski (1987), inflated to $93 using CPI, and adjustment factor = 0.958.
Adjustment factor used so that predicted cost = actual reported cost.

Table B. : Air Route Traffic Control Center Operations

Aircraft Type	IFR Departure	IFR Over	Total AC Handled
LAX			
Air Carrier	248,248	102,429	598,926
Air Taxi	84,483	595	169,561
Gen Aviation	63,317	7,403	134,037
Military	58,573	25,529	142,676
Total	454,621	135,956	1,045,199
LA Dept of AP			
Air Carrier	302,549	124,834	729,931
Air Taxi	102,962	725	206,649
Gen Aviation	77,166	9,022	163,355
Military	71,385	31,114	173,884
Total	554,062	165,694	1,273,819
CA State Total			
Air Carrier	785,264	324,005	1,894,533
Air Taxi	267,238	1,882	536,338
Gen Aviation	200,285	23,417	423,987
Military	185,280	80,755	451,315
Total	1,438,067	430,059	3,306,173
All US			
Air Carrier	6,314,530	6,352,061	18,981,121
Air Taxi	2,863,077	479,345	6,205,499
Gen Aviation	3,069,589	1,294,103	7,433,281
Military	1,706,134	1,419,372	4,831,640
Total	13,953,330	9,544,881	37,451,541

Source: *FAA Air Traffic Activity Statistics* (1993)

Table B.3: Instrument and Airport Operations

Aircraft Type	Instrument Operations: Approaches (no ARTCC)	Instrument Operations: Total Instr Operations	Airport Operations: Itinerant Operations	Airport Operations: Local Operations
LAX				
Air Carrier	39,495	411,642	411,601	0
Air Taxi	21,227	205,090	204,947	0
Gen Aviation	3,413	62,707	48,933	2,545
Military	1,350	14,266	13,727	92
Total	65,485	693,705	679,208	2,637
LA Dept of AP				
Air Carrier	40,163	501,682	501,646	0
Air Taxi	21,472	247,605	248,191	0
Gen Aviation	6,876	156,609	363,537	233,023
Military	1,357	22,877	18,218	38,156
Total	69,868	928,773	1,131,592	271,179
CA State Total				
Air Carrier	104,037	1,539,239	1,359,057	0
Air Taxi	60,274	1,208,726	981,198	0
Gen Aviation	86,339	2,356,634	4,098,598	3,340,431
Military	4,134	553,708	74,668	77,202
Total	254,784	5,658,307	6,513,521	3,417,633
All US				
Air Carrier	821,600	13,639,757	12,581,148	0
Air Taxi	618,221	10,446,851	9,675,955	0
Gen Aviation	777,397	17,732,198	20,376,766	14,851,004
Military	92,121	3,880,791	1,387,088	1,236,192
Total	2,309,339	45,699,597	44,020,957	16,087,196

Source: *FAA Air Traffic Activity Statistics* (1993)

Table B.4: Flight Service Station Operations

Aircraft Type	Flight Plans IFR-DVFR	Flight Plans VFR	Pilot Briefs	Aircraft Contacted IFR-DVFR	Aircraft Contacted VFR
LAX Share					
Air Carrier	1,450	2	874	430	6
Air Taxi	5,611	459	5,643	1,662	1,149
Gen Aviation	10,512	9,129	52,095	3,114	22,839
Military	1,071	447	2,884	317	1,120
Total	18,645	10,038	61,496	5,522	25,114
LA Dept of AP					
Air Carrier	2,984	5	1,798	884	12
Air Taxi	11,543	945	11,609	3,419	2,365
Gen Aviation	21,627	18,781	107,176	6,406	46,987
Military	2,204	921	5,934	653	2,303
Total	38,358	20,652	126,517	11,361	51,667
CA State Total					
Air Carrier	21,125	34	12,730	6,257	85
Air Taxi	81,721	6,692	82,191	24,205	16,741
Gen Aviation	153,111	132,966	758,770	45,350	332,654
Military	15,605	6,518	42,009	4,622	16,306
Total	271,562	146,209	895,701	80,434	365,786
All US					
Air Carrier	676,640	3,410	419,545	172,664	7,013
Air Taxi	148,492	17,734	173,637	37,892	36,471
Gen Aviation	3,407,707	1,377,688	8,646,172	869,574	2,833,291
Military	461,081	96,019	735,818	117,658	197,468
Total	4,693,920	1,494,851	9,975,172	1,197,788	3,074,243

Source: *FAA Air Traffic Activity Statistics* (1993)

Table B.5: Summary of FY 1993 ATC Costs

	Cost of ATC Service				
AP/Region	ARTCC	TRACON	ATCT	FSS	Total ATC
LAX					
Air Carrier	$48	$33	$0	$0	$80
Air Taxi	$13	$16	$0	$1	$30
Gen Aviation	$11	$1	$0	$2	$14
Military	$11	$1	$0	$0	$12
Total	$83	$50	$0	$3	$136
LA Dept of AP					
Air Carrier	$63	$40	$0	$0	$103
Air Taxi	$18	$19	$0	$1	$38
Gen Aviation	$7	$2	$2	$4	$15
Military	$16	$1	$1	$0	$18
Total	$103	$62	$3	$6	$174
CA State Total					
Air Carrier	$164	$122	$0	$2	$288
Air Taxi	$46	$94	$0	$8	$148
Gen Aviation	$18	$27	$24	$32	$101
Military	$41	$30	$0	$2	$73
Total	$268	$274	$24	$44	$610
All US					
Air Carrier	$1,643	$1,085	$0	$51	$2,779
Air Taxi	$527	$815	$0	$17	$1,359
Gen Aviation	$312	$203	$84	$385	$983
Military	$436	$210	$0	$45	$691
Total	$2,917	$2,313	$84	$498	$5,812

APPENDIX C :

ESTIMATION OF REVENUES FROM LAX AND CA TO THE AATF

The revenues are generated through four taxes:

- Domestic Passenger Ticket Tax (DPTT), accounting for 10% of the ticket price;
- International Departure Tax (IDT), $6 per international enplanement;
- Freight and Waybill Tax (FWT), 6.25% of the value of cargo transshipments;
- Fuel Tax (FT), $0.15/gal on aviation gasoline, $0.175/gal on jet fuel, paid only by General Aviation.

This calculation is primarily based on the data provided by the Los Angeles Department of Airport's 1993 Annual Report and the Onboard T-3 and O&D Plus Databases.

The T-3 Database shows the total number of enplaned passengers, domestic and international, at a particular airport, to all destinations. The O&D Plus Database is a domestic Origin to Destination Database. Because it only takes into account the domestic O&D passengers, the number of passengers shown here is significantly lower than the results given by the T-3 Database. One feature of the O&D Plus database is that it contains an estimate, based on a 10% sample, of the average fare paid by passengers originating from a particular airport. Therefore, as only the O&D passengers pay taxes, this estimate of the revenue is considered as accurate for the DPTT.

Los Angeles International Airport (LAX)

First, the ratio of the total number of enplaned passengers to the total number of passengers is 0.47. Then, the total number of domestic (international) passengers given by the Annual Report is multiplied by 0.47 to find the number of enplaned domestic (international) passengers. The IDT can also be computed. It should be noted that, given the importance of LAX as a major international airport, the ratio of DPTT to IDT is significantly different from the national average. Due to data limitations, a weighted share of national revenues generated is used to approximate the FWT and the FT (table C.1)

The revenues based on passenger ticket taxes are considered as accurate, whereas receipts from freight and fuel taxes probably are not. However, for the whole system, freight and fuel receipts account for only 7.4% of the total receipts to the AATF (7% for LAX based on our calculations). Therefore, under the assumption that the real value of the FWT and FT is twice the estimated one, the accuracy of the estimate of the total revenues generated by LAX still remains at an acceptable 7% level (3.5% if the real value of FWT and FT is half the estimated one).

CALIFORNIA

The results for California are based on the T-3 Onboard and O&D Plus Databases. As mentioned before, the O&D database does not take into account the transfers. However, for airports smaller than San Diego or Ontario, this amount is negligible, as is the difference between the results of the two databases.

Therefore, for airports where the difference is small, domestic enplanement data from the O&D Plus database are considered as accurate for the number of domestic passengers enplaned, and the number of international passengers enplaned is taken as the difference between the result of the T-3 database and the one of the O&D Plus database. It is to be noticed, consequently, that the number of international passengers (and then the International Departure Tax) will be an upper bound.

The DPTT is taken from the O&D Plus database results, and the IDT is computed with the number of international passengers found following the above methodology. Finally, the FWT and FT are approximated using the same methodology as for L AX.

Table C.1: Airport and Airway Trust Fund Receipts attributable to California

	Total Enplaned Pax[(a)] (millions)	Domestic Enplaned Pax[(b)]	International Enplaned Pax[(c)]	DPTT[(d)] ($million)	FWT[(e)]	IDT[(f)]	FT[(g)]	TOTAL
LAX	22.3	16.8	5.5	191.0	10.9	33.2	5.7	240.8
SFO	14.9	12.9	2.0	146.1	8.3	12.1	4.0	170.6
SAN	5.8	5.1	0.7	62.7	3.6	4.1	1.7	72.1
SJC	3.3	2.6	0.7	40.0	2.3	3.9	1.1	47.3
OAK	3.5	3.3	0.2	29.2	1.7	1.2	0.8	32.8
ONT	3.0	2.9	0.2	32.7	1.9	1.0	0.9	36.5
SNA	2.9	2.6	0.2	42.3	2.4	1.3	1.1	47.1
SMF	2.6	2.4	0.2	28.1	1.6	1.0	0.7	31.4
BUR	2.1	2.0	0.1	15.6	0.9	0.5	0.4	17.4
FAT	0.4	0.3	0.1	5.4	0.3	0.7	0.2	6.6
PSP	0.4	0.3	0.1	6.1	0.3	0.6	0.2	7.2
LGB	0.3	0.3	0.0	3.6	0.2	0.1	0.1	4.0
SBA	0.3	0.2	0.1	3.7	0.2	0.4	0.1	4.4
MRY	0.2	0.2	0.1	2.9	0.2	0.3	0.1	3.5
BFL	0.1	0.1	0.0	1.9	0.1	0.2	0.1	2.2
SBP	0.1	0.1	0.0	1.1	0.1	0.2	0.0	1.4
ACV	0.1	0.0	0.0	0.6	0.0	0.2	0.0	0.9
RDD	0.1	0.0	0.0	0.7	0.0	0.1	0.0	0.9
STS	0.0	0.0	0.0	0.5	0.0	0.1	0.0	0.6
SMX	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.8
MOD	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.4
California	**6 .3**	**43.7**	**10.**	**$615**	**$35**	**$61**	**$17**	**$7 9**

(a). Out of the T-3 Database.
(b). Exact value for LAX, SFO and ONT, from the Annual Reports. For the others, minimum value given by the O&D+ Database.
(c). Exact value for LAX, SFO and ONT. For the others, difference between the total- and the number of domestic passengers enp
It is therefore a maximum.
(d). Domestic Passenger Ticket Tax.
(e). Freight and Waybill Tax.
(f). International Departure Tax.
(g). Fuel Tax.

APPENDIX D:

ESTIMATION OF PASSENGERS-KILOMETERS ATTRIBUTABLE TO CALIFORNIA

Only two types of passenger kilometers traveled are being considered : intrastate pkt flown between 2 airports inside California, and interstate pkt flown between any California airport and any US airport out of California. The overflights over California are neglected as well as the international flights : the former account for a very small number of passengers, and the latter for very few pkt in the national aviation system.

Intra-California

Intrastate flights account for the pkt flown exclusively between California airports. In order to prevent double counting, only originating passengers are considered. For intrastate flights, round-trip mileage is considered attributable to California.. PKT is estimated based on figures from the T-100 Onboard database, which contains the total number of passengers who fly out of one airport during 1993. The distance between the airports is given by the O&D Plus database.

The results are shown in Table D.1. For example, 595 million pkt out of Burbank have been "flown" over California into (other) California airports in 1993.

Table D.1: Passenger-Kilometers Flown attributable to California

(pkt in millions)

	Intrastate	Interstate			
		Over California		Over the US	
	(Outbound)	One Way	Round-Trip	One Way	Round-Trip
BUR	595	428	855	720	1,440
LAX	1,446	5,042	10,084	25,901	51,802
OAK	1,054	700	1,400	1,933	3,866
ONT	547	843	1,686	2,579	5,159
SAN	1,055	1,531	3,063	6,311	12,623
SFO	1,654	3,510	7,020	20,396	40,793
SJC	552	858	1,716	3,342	6,685
SMF	764	419	837	2,029	4,058
SNA	499	847	1,693	3,104	6,208
Total CA	8,166	14,177	28,355	66,317	132,635

Interstate
Interstate flights account for pkt flown between any California airport to any US airport outside California. Two approaches are considered. First, the number of pkt flown over California is computed. Second, the number of pkt flown over the whole system (the US) is also approximated. In the latter case, only the one-way mileage is considered attributable to California.

Over California
For each flight between an airport in California and a non-CA US airport, the distance flown over California is estimated. Based on the number of passengers from the T-100 Onboard Database, an estimation of the pkt (one way and round-trip) flown over California attributable to interstate flights is computed.

Over the US
The estimate of pkt flown in the whole national aviation system attributable to California is computed by multiplying the number of passengers on each link (given by the T-100 Onboard database) and the length of the link (given by the O&D Plus database). In order to obtain the results shown in table 2.8, the second approach, using the one-way figure, has been chosen.

Sources

Allen, Duncan/De Leuw, Cather & Company. Cross-Corridor Comparison of Operating Costs for High Speed Ground Transportation. TRB paper # 97-1135.

Budget of the U.S. Government. 1994-95. HJ 2051 A6

California Intercity High Speed Rail Commission. High-Speed Rail Summary Report and Action Plan. December 1996.

Caltrans. California Aviation System Plan: Financial Element. Draft document, July 1995.

Caltrans. State Dollars for Your Airport: A Guide to State Aviation Funding Programs. 1995.

Charles River Associates. Independent Ridership and Passenger Revenue Projections for High Speed Rail Alternatives in California. Prepared for the California Intercity High Speed Rail Commission, July 1996.

City of Los Angeles Department of Airports, 1993 Annual and Financial Reports. RTS 848.A1

Congressional Budget Office. Paying for Highway, Airways, and Waterways: How Can Users Be Charged?. U.S. Government Printing Office: 1992.

Duffey, Marilyn/Woodward-Clyde Consultants. High Speed Rail Corridor Feasibility. TRB paper # 97-0888.

Harrison, John/Parsons Brinckerhoff Quade & Douglas. The Cost of Speed: Analysis of Capital Cost Estimates for High Speed Ground Transportation Systems. TRB paper # 97-1057.

Institute of Transportation Studies, University of California at Berkeley. Levinson, Gillen, Kanafani and Mathieux, The Full Cost of Intercity Transportation - A Comparison of High Speed Rail, Air and Highway Transportation in California. UCB-ITS-RR-96-3, June 1996

Morris, Hugh and John DeCicco/American Council for an Energy-Efficient Economy. Revisiting the Extent to which User Fees Cover Road Expenditures in the United States. TRB paper # 97-0341.

National Railroad Passenger Corporation (Amtrak). 1990 Annual Report.

Ontario Round Table on Environment and Economy. "Externalities and Transportation Subsidies in Other OECD Countries," Full Cost Transportation Pricing Study. 1995.

Richard Golaszewski, "The Unit Costs of FAA Air Traffic Control Services," Journal of the Transportation Research Forum, v.28.1, 1987.

San Francisco International Airport, 1993 Annual and Financial Reports, RTS 5044.S376

Shearin, Gui/De Leuw, Cather & Company. Methodology Development for Estimating External Benefits and Costs of High Speed Ground Transportation in the United States. TRB paper # 97-1096.

State of California. Governor's Budget Summary.

U.S. General Accounting Office Testimony. Amtrak: Deteriorated Financial and Operating Conditions. GAO/T-RCED-95-90, 1995.

U.S. General Accounting Office Testimony. Amtrak: Key Decisions Need to Be Made in the Face of Deteriorating Financial Condition. GAO/T-RCED-94-186, 1994.

U.S. General Accounting Office. Amtrak: Limited Income from the Revenue Enhancement Program. GAO/RCED-90-76, 1990.

U.S. General Accounting Office. Intercity Passenger Rail: Financial and Operating Conditions Threaten Amtrak's Long-Term Viability. GAO/RCED-95-71, 1995.

United States Bureau of Census data regarding California State and Local Government Finances, 1992-93.

USDOT. Highway Cost Allocation Study Plan. 1979.

USDOT. National Transportation Strategic Planning Study. 1990.

USDOT/BTS. Federal, State and Local Transportation Financial Statistics: Fiscal Years 1982-1992. DOT-VNTSC-BTS-95-2, June 1995.

USDOT/FAA. Airport and Airway Costs: Allocation and Recovery in the 1980's. FAA-APO-87-7, 1987.

USDOT/FAA. FAA Air Traffic Activity, Fiscal Year 1993, 1994.

USDOT/FAA. Statistical Handbook of Aviation, Calendar Year 1993. FAA-APO-95-5.

USDOT/FHWA. Highway Statistics 1993. FHWA-PL-94-023, October 1994.

Vaca, Erin. Intercity Rail Ridership Forecasting and the Implementation of High-Speed Rail in California. University of California Transportation Center Working Paper #182, 1993.