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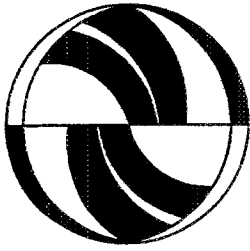
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Reprint
UCTC No 164

**The University of California
Transportation Center**
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Employee Trip Reduction in Southern California: First Year Results

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EMPLOYEE TRIP REDUCTION IN SOUTHERN CALIFORNIA: FIRST YEAR RESULTS

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Abstract— Trip reduction policies are increasingly utilized in U S metropolitan areas to address congestion and air quality problems. These policies typically focus on the journey to work and are aimed at reducing the amount of drive-alone commuting by providing transit and ride-sharing incentives. Severe air quality problems in Southern California have prompted the air pollution control agency for the Los Angeles metropolitan area to enact Regulation XV. The regulation requires employers to develop and implement a trip reduction program to achieve specified ride-sharing goals. It is the most ambitious and far-reaching such program implemented to date, and offers a unique opportunity to determine whether such programs can significantly affect travel behavior. This paper presents results from the first year of Regulation XV's implementation.

INTRODUCTION

Transportation demand management (TDM) has emerged as a policy of choice for dealing with increasing traffic congestion in major American cities. TDM is aimed at reducing congestion by reducing or restricting travel demand, rather than by providing greater capacity in transportation facilities. TDM includes strategies such as shifting solo drivers to car-pools or transit, allowing more employees to work at home or adjusting work schedules to avoid peak-period auto travel. Renewed concerns regarding the air quality impacts of traffic congestion in major metropolitan areas have intensified the use of TDM policies. One of the most far-reaching TDM experiment is taking place in the Los Angeles metropolitan area. The increasing stringency of state and national air quality standards led the South Coast Air Quality Management District (SCAQMD), the air pollution control agency for the Los Angeles metropolitan area, to enact Regulation XV, which requires employers to take responsibility for encouraging workers to consider alternatives to driving to work alone. This paper presents an analysis of the Regulation's effectiveness in achieving its peak-period trip reduction goals after the first year of implementation.

Extensive research on travel behavior over the past two decades documents that individuals make travel choices based primarily on cost and convenience (Wachs, 1990). Since the single occupant personal auto is the most convenient mode and is moderately priced as well (given current U S policies), it is the overwhelmingly dominant mode of travel in

U S metropolitan areas. The trend of increasing solo-driver commuting has continued through the 1980s, despite rising traffic congestion through the same period (Pisarski, 1992, Hanks and Lomax, 1991).

TDM policies seek to encourage the provision of incentives and disincentives to reduce drive-alone commuting. TDM programs have a long history, going back at least to the Second World War. While early programs were voluntary and employer-based, current programs are often far broader in scope and required by law (Giuliano & Wachs, 1993, Orski, 1990). Although some programs are performance-based (that is, required trip reduction goals are specified), the incentives or policy elements to be used to achieve performance goals are left to the discretion of the program implementor. Prior research suggests that the travel behavior changes required to reduce peak vehicle trips can be achieved if sufficiently strong or effective incentives are provided (Wachs, 1990). These include parking charges and restrictions, carpool and transit subsidies and other monetary incentives. However, TDM programs typically do not employ such incentives because they are costly and often controversial. Consequently, experience to date with TDM programs is mixed. Several case studies provide anecdotal evidence of successful programs (Ferguson, 1990, Higgins, 1990, Kuzmyak and Schreffler, 1989), but there is little systematic evidence that TDM can achieve broad trip reduction goals. The SCAQMD's imposition of Regulation XV thus provides a unique opportunity to evaluate the potential effectiveness of such approaches.

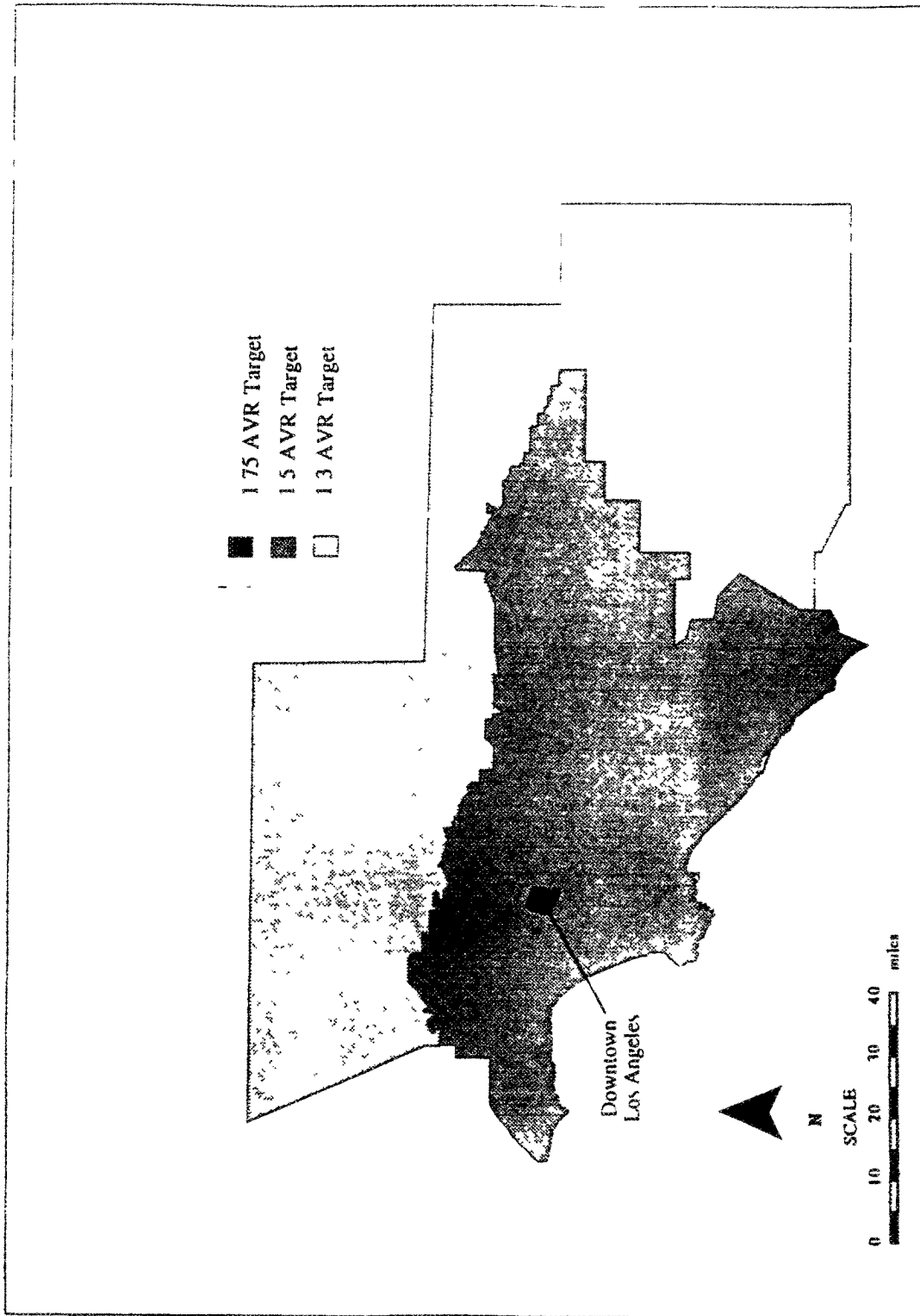


Fig 1 South coast air quality management district AVR target areas

PROVISIONS OF REGULATION XV

The SCAQMD is the regional agency responsible for developing and implementing the Air Quality Management Plan for the Los Angeles metropolitan area. Because of the severe air quality problem in this region, exacerbated by rapid population and economic growth, topography and climate, the air quality management plan calls for behavioral changes as well as technological advances in the control of stationary and mobile sources of air pollution. One of the most challenging requirements of the plan is the substantial reduction of automotive air pollution by reducing reliance upon singly occupied automobiles for journeys to and from work. While work trips are known to be decreasing as a proportion of all travel, they constitute more than a third of all daily trips and are made primarily at peak hours, when congestion is most severe. Work trips are also believed to be more susceptible to change, since alternative travel options are more likely to be available for work trips than they are for trips made for other purposes.

The implementation of Regulation XV began July 1, 1988. It requires that public and private employers having 100 or more employees at any worksite complete and file a plan for that site by which they intend to increase the *Average Vehicle Ridership* to a specified level within one year of the SCAQMD's approval of its plan. As of June 1, 1992, nearly 6200 employment sites had filed initial or updated Regulation XV plans. An estimated 2.26 million employees, constituting about 40% of the District's 5.4 million work force, work at these sites.¹ Average vehicle ridership (AVR) may be defined roughly as the quotient of the number of employees reporting to work between 6:00 and 10:00 am, divided by the number of motor vehicles driven by these employees. The ratio is calculated over a 5-day work week to account for the growing use of modified work weeks, and certain adjustments are made to the ratio to account for employees who telecommute. Employees, for example, who arrive at work on bicycles or as passengers in vans driven by others contribute to the numerator but not to the denominator, thus increasing the AVR. Credits are also given for employees who travel to work in automobiles powered by clean fuels such as methanol, propane and electricity.

Compliance with the Regulation requires three tasks: 1) submission of an implementation plan within 90 days of notification, 2) designating and training of an on-site Employee Transportation Coordinator (ETC) and 3) approval of the plan by

SCAQMD. The implementation plan must describe how the established AVR target will be reached within 1 year. AVR targets are determined by geographic location: 1.75 for the central business district of Los Angeles, where transit access is high and ride-sharing is already extensive, 1.5 for the developed urban and suburban areas, and 1.3 for outlying, low density areas (see Fig. 1).² Based on available data, we estimate that the regional average AM peak vehicle occupancy (roughly equivalent to AVR) was somewhere between 1.1 and 1.2 at the inception of the program.

The implementation plan may consist of any number and combination of incentives and disincentives. Typical examples include preferential parking locations for carpools and vanpools, transit pass subsidies, ride-share matching procedures and promotional activities. The second requirement for compliance is the designation of at least one employee at each worksite to become a certified Employee Transportation Coordinator (ETC). The ETC must complete a 3-day training program prior to the submission of the first plan, and must receive 1 day per year of "up-date" training to remain certified.

The third requirement is SCAQMD approval. The SCAQMD staff may reject the plan and require resubmission if the plan does not seem appropriate for either substantive or procedural reasons. Once the plan is approved, the employer must implement it. Employers are not subject to fine for not achieving the AVR targets, but they can be fined if they fail to implement an approved plan. Employers must annually update their plans, and if the target has not been reached, the SCAQMD may require a more aggressive plan. Table 1 summarizes Regulation XV activity between July 1, 1988 and June 1, 1992, and illustrates the extent of the public and private effort that has gone into its implementation. It also shows that enforcement has been aggressive: hundreds of firms have been fined for violating its provisions. The most common reason for being found in violation is simple failure to submit a plan. The single largest fine levied to date has been \$150,000, in the case of a large regional retaining firm. Fines through June 1, 1992 have amounted to \$2 million. In addition, some 260 worksites have been audited by SCAQMD to determine whether or not they are complying with the Regulation on a daily basis. Of these, 96 were issued notices to comply and 9 were issued notices of violation.

METHODOLOGY AND DATA

In order to determine how implementation of Regulation XV is affecting travel behavior we ideally would like to examine results from a representative

¹Our estimate of the SCAQMD area's workplace is based on estimated 1989 annual averages by county published by the U.S. Department of Commerce, (U.S. Department of Commerce, 1991). Our estimate of the number of employees subject to Regulation XV is based on the employers' reported number of employees.

Boundaries of the AVR target areas are based on SCAQMD receptor areas, and thus do not coincide with municipal or census geographic units.

Table 1 Summary of actions taken under regulation XV July 1, 1988 through June 1, 1992

Notices Sent to Employers (Including Initial Notices and Annual Update Notices)	13,414
Plans Approved by SCAQMD (Initial and Update Plans)	8775
Employers Found to be Exempt (Out of Business, Fewer than 100 Employees, etc)	1675
Plans Being Evaluated by SCAQMD Staff (Submitted but not yet approved or disapproved)	1046
Violation Notices Issued	274
Cases Settled, Employers Fined Plans Received	264
(Initial and Update Plans)	10 068

sample of employment sites, with representatives determined by the factors that affect employee commuting behavior. Our research problem is illustrated in Fig. 2. Commuting behavior (expressed as "AVR") is a function of environmental characteristics, employee characteristics and intraorganizational characteristics, as well as the set of incentives contained in the Regulation XV plan. Environmental characteristics include the availability of transit and other alternatives to driving alone, the level of traffic congestion, parking availability, etc. Employee characteristics include commute distance, income, auto availability and related household characteristics. Intraorganizational factors include the need to have employees at work at the same time, the extent to which work-related individual vehicle travel is required, the flexibility of operating hours, etc.

We also expect that the nature and effectiveness of the Regulation XV plan will be affected by these three sets of factors. For example, the compressed

work week may be less viable for jobs that cause significant physical or mental fatigue, free transit passes may have little effect in areas poorly served, but a significant effect in areas with good transit access, particularly among low-wage workers.

Our data source is the SCAQMD Regulation XV database, which contains plan descriptions, geographic locations, transportation system and firm characteristics for each employment site. Employee data are limited to summaries of occupation, home zip codes and mode choice. The database has some significant limitations. First, data on individual employees is not available. In addition, many details relating to reporting requirements, AVR definitions, etc., have changed over the course of Regulation XV's implementation.

Our research objective is to determine whether Regulation XV has had a significant impact on AVR. The first year plan provides data on baseline conditions, the annual update provides results after one year of implementation. We selected as our sample all employment sites in the data files for which both first and second year plans were approved and available as of August 1991. After eliminating cases with inconsistent data, our sample included 1110 sites, or 77% of all sites with second year plans approved as of our cutoff date. Our sample also comprises 27% of the 4032 worksites that had approved plans as of mid-August 1991.

RESULTS

We discuss our findings in four parts. First, we discuss the representativeness of our sample. Second, we present descriptive statistics on baseline conditions of the subject firms. Third, we show how commuting behavior has changed at the 1110 sites for which comparable data were available. Finally, we

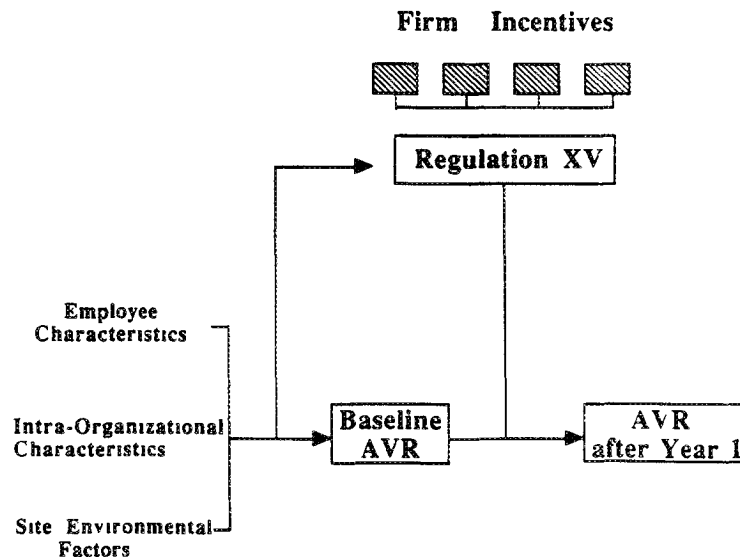


Fig. 2 The research problem

provide some preliminary analysis of the effectiveness of the incentives provided in the Regulation XV plans

Sample representativeness

In order to be able to generalize first year results to the population of firms subject to the Regulation, we must determine whether they are representative with respect to the characteristics that affect AVR or changes in AVR. Because the phasing of notification has been based on site size, we expect our sample to overrepresent worksites having larger numbers of employees. We had no prior expectations regarding other characteristics, such as location or type of company.

We estimated analysis of variance models of baseline AVR as a function of site characteristics to establish a basis for testing sample representativeness. We use the model to test whether AVR or the change in AVR after one year of implementation is significantly related to site characteristics. We then compare our sample to the population with respect to these characteristics. We hypothesize that AVR would depend on (a) geographic location, a surrogate for development density and transit access, (b) size, as measured by number of employees at the site, (c) industrial sector, a rough surrogate for occupational mix and intraorganizational characteristics, and (d) date of employee survey, to control for seasonality as well as changes in local economic conditions that might affect ride-sharing behavior.

The database gives employment site location by zip code, zip codes were aggregated to areas to capture differences in urban structure while keeping the total number of categories to a minimum. This process resulted in the generation of three categories: "downtown," the greater downtown area, "metro central", the remainder of Los Angeles County south and east of the Santa Monica mountains, and "metro suburbs," the remainder of the region (see Fig. 3). These categories were developed from earlier research on population and employment densities in the southern California region (Giuliano and Small, 1991).³ Industrial sector is given by three-digit SIC code. However, because of missing data and questionable SIC assignments, these were reduced to one-digit classifications. The single-digit codes were aggregated to three categories: manufacturing, service related (service, finance, insurance and real estate (FIRE), public administration, trade) and all others. Size of the site's work force was divided into four categories (100-249, 250-499, 500-999, 1000 and above).

³These geographic location categories do not coincide with the AVR target areas not only because they are based on different geographic units, but also because our location categories are based on 1980 census population and employment densities and thus better reflect differences in development densities within the region.

Results for a "best fit" analysis of variance model are given in Table 2. As expected, both area and industry are significantly related to AVR, while size is significant only jointly with industry. Wholesale and retail trade firms tend to be relatively small and have a higher than average AVR, transportation/communication firms tend to be large and have a lower than average AVR. No other variables were found to be significant. The available data from all sites with approved plans (3802 cases) can be used to provide comparisons between the sample used in this analysis and the population of sites participating in Regulation XV. Table 3 shows that the sample differs substantially in terms of site size, and there are some differences in industrial sector, again due to the phasing of notifications. These differences account for the slightly higher AVR of the total population of sites. The same model was also estimated with the change in AVR after one year of implementation as the dependent variable. None of the independent variables was individually or jointly significant.⁴ With respect to examining changes in AVR, then, the sample is adequate.

Baseline modal characteristics

The baseline modal profile is shown in Table 4. Numbers reported here are weighted by site size and thus represent averages of the sample of employees. Over three quarters of commuting is by single-occupant auto, and carpooling is by far the dominant form of ride-sharing. The bus share is just over 3%, with walking or biking nearly as frequent as bus use. Vanpooling, telecommuting and compressed workweek (CWW) are quite uncommon. Only one-fourth of all sites have any vanpools or CWW schedules, and telecommuting exists at only one-eighth of all sites. These baseline characteristics are quite consistent with other data sources such as local vehicle occupancy counts and commuter survey results.

The modal share distribution also depends on geographic location and industrial sector. Analysis of variance tests were conducted for each mode to determine whether geographic location or industrial sector either singly or jointly affects mode share. Modes tested included drive alone, carpool, van, bus and all others. Industrial sector was found to be significant in all cases and to be significant jointly with location in all cases except all other modes. Geographic location was found to be significant for drive alone, carpool and bus. For example, Table 5 gives baseline mode shares for manufacturing and service sectors by location. Drive-alone shares are quite comparable within each location category, with the drive alone share much lower among downtown firms as expected. Differences between industrial sectors are more apparent for carpool and bus. Carpooling is more extensive among manufacturing

⁴Note F - ratio = 1.29, n = 1067

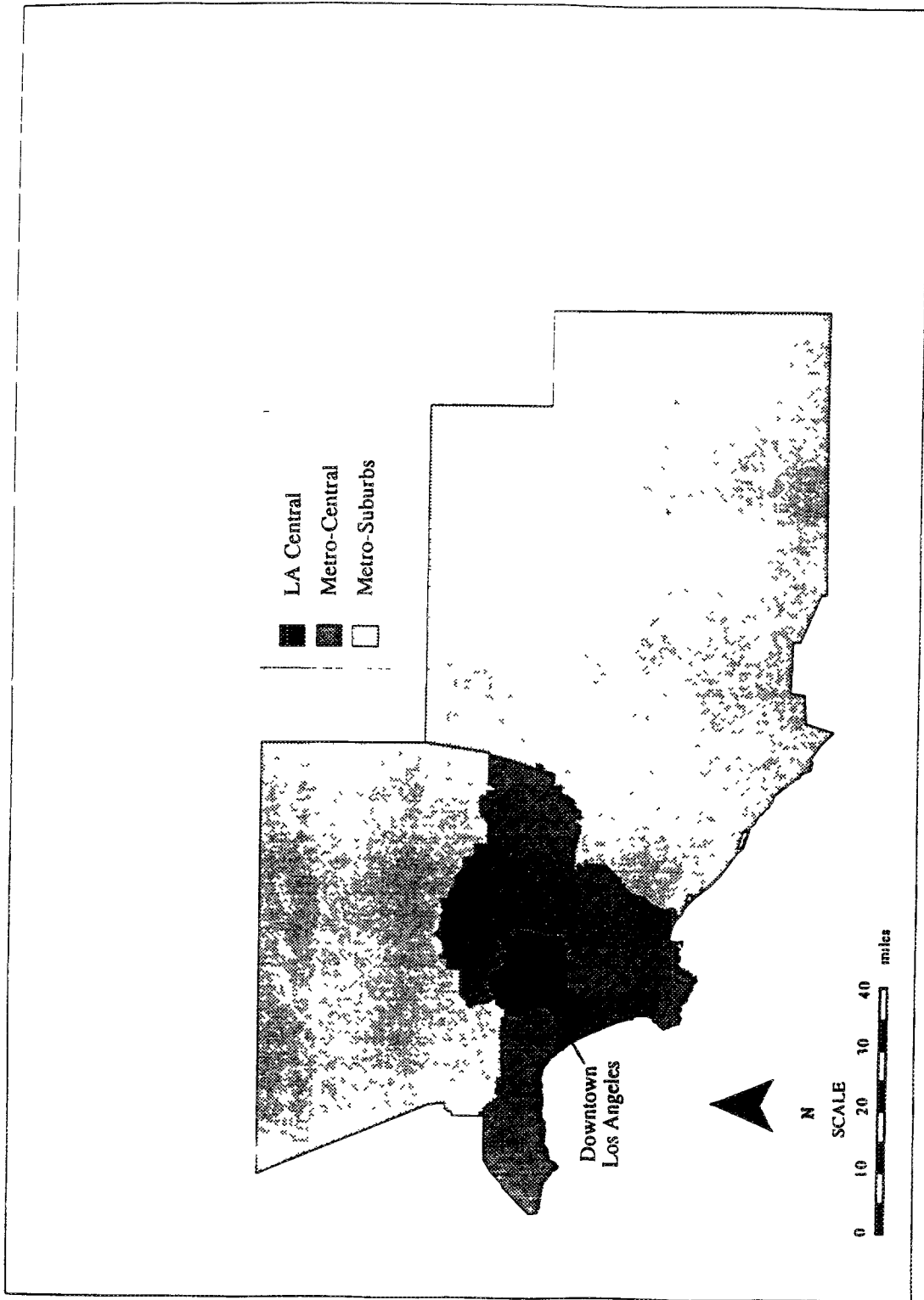


Fig 3 South coast air quality management district by geographic classification

Table 2 Analysis of variance baseline AVR

Source of Variation	Mean Square	F
Main Effects	0.542	17.84**
Area	1.371	45.16**
Industry	.527	17.34**
Size	.032	1.03
Two-way Interactions	.060	2.09
Area by Industry	.060	2.03
Area by Size	.030	.99
Industry by Size	.100	3.23*
Three-way Interactions	.090	2.78
Explained	.170	5.55**
N = 1067		

*significant at $p \leq .05$ **significant at $p \leq .01$

firms in all locations, while bus and "other" modes are relatively more extensive among service firms. Greater use of the compressed workweek accounts for the higher proportion within the "other" category among service firms located outside of downtown. These differences likely reflect differences in the nature of work between industrial sectors which in turn influence the potential use of alternative commuting modes.

Changes in commuting behavior

The single most important indicator of the effectiveness of Regulation XV is the change in average vehicle ridership which has been attained in the first full year since the program was implemented. As described earlier, our comparisons are based on the reported AVR and modal shares in the approved initial (baseline) and first update Regulation XV plans. It should be noted that the *actual* time interval between initial and first update survey dates averages 16 months and varies between 3 and 30 months, depending upon when the firm was notified to submit the update plan and how long it took to get it ap-

Table 3 Sample and population characteristics

	Year One Year Two Sample	Total Year One Population
Location		
Downtown	12%	13%
Metro-Central	46%	45%
Metro-Suburbs	42%	42%
Industry		
Other	18%	12%
Manufacturing	36%	33%
Service & Related	46%	55%
Size		
< 250	28%	68%
≥ 250 < 500	35%	21%
≥ 500 < 1,000	22%	6%
≥ 1,000	15%	5%
AVR	1.213	1.219
N	1110	3802

Table 4 Baseline average modal shares

Mode	% Share
Drive Alone (DA)	75.7%
Carpool (CP)	13.8%
Vanpool (VP)	2.1%
Bus (B)	3.2%
Walk/Bike (W/B)	2.9%
Telecommute (TEL)	0.6%
Compressed Workweek (CWW)	1.6%
N = 1110	

proved and filed.⁵ In addition, the first year of implementation time interval covers the entire period of mid-1988 through mid-1991.

For the entire sample, the mean AVR increased 2.7%, from 1.213 to 1.246. The average change in AVR was 3.4%, but the range was very large, from -28% to +84%. AVR increased at 69% of the sites and decreased at 31% of the sites over the first year of implementation period. Nineteen percent of the sites had increases of more than 10%, and half of the sample had increases of up to 10%.

Frequency distributions of baseline and AVR after one year of implementation are graphed in Fig. 4. The pattern observed in the figure is very clear. A large proportion of worksites at which initial AVRs were very close to 1.0 experienced increases in AVR, causing a drop in the proportion of all worksites having very low values of AVR. Between AVR values of 1.2 and 1.55 there were increases in the number of worksites in each AVR group. Among worksites with AVR greater than 1.55, the pattern of changes is more mixed.

We examined the data to explore possible relationships between changes in AVR and a number of other variables, including the size and location of worksites and industry groups. As discussed previously, none of these was found to be significantly related to the change in AVR. Improvements in AVR were more likely among sites with lower starting values of AVR. For example, the baseline AVR for all sites that experienced a *decrease* was 1.32, as compared with an initial value of 1.21 for the sample as a whole.

It may be recalled that the objective of Regulation XV is to achieve the specified AVR targets. The pattern of greater improvements in AVR occurring among sites with lower baseline AVR is apparent when we group the sample by AVR target, as shown in Table 6. The group mean of 41 sites in the 1.75 target group remained unchanged at 1.47, while the group mean of sites in both the 1.50 and 1.30 target groups increased by 3%. The number of worksites meeting the target AVR actually *decreased* during the first year of the program. Most of the decline is accounted for by sites in the 1.75 target group, where

⁵A 3-month interval is possible if an initial plan had been rejected because of an inadequate employee survey.

Table 5. Baseline mode shares by location and industry

	Downtown		Metro Central		Metro Suburbs	
	Manuf	Service	Manuf	Service	Manuf	Service
Drive Alone	671	665	782	719	792	789
Carpool	201	146	143	138	144	114
Van	007	012	034	025	016	009
Bus	078	106	017	042	014	018
Other	044	072	024	076	035	071

the number of sites meeting the target decreased from 10 to 5. These results are not surprising. Prior research suggests that the "ambient" level of ride-sharing (6–10%) can be increased rather easily by providing basic incentives such as ride-matching services. Persuading very large numbers of commuters to use transit and ride-share is much more difficult (Orski, 1990).

In view of the time period over which these AVR comparisons were made, it is also important to consider whether other external factors may have affected changes in AVR. Both the Gulf War (which generated large fluctuations in gasoline prices) and the 1990–91 recession could affect AVR. The sample firms were clearly affected by the recession, total work force among the sample sites declined by 2.7%, and half of the sites reported a reduction in the number of employees between the initial and updated plans. We regressed change in AVR on survey date and other factors (industry, size, location). None of the equations were significant. We also verified that the change in AVR was not due to shifts of employees out of the 6AM to 10AM arrival period. We therefore conclude that the AVR change is related to the implementation of Regulation XV.

Another important measure of the impact of Regulation XV is the change in modal split. Results are summarized in Table 7. The proportion of workers driving to work alone decreased from 75.7% to 70.9%. The largest shift in mode was toward carpooling: the carpool mode share increased from 13.8% to 18.4%, accounting for nearly all of the decrease in driving alone. Slight changes in other modes were essentially offsetting. These modal shifts resulted in a reduction of auto trips from 84 per 100 employees to 80 trips per 100 employees.

Analysis of variance tests were also conducted to determine whether the changes in modal shares are related to other employment site characteristics, namely site location, size and industrial sector. None of these were found to be significant. Rather, the reduction in the drive-alone share is quite consistent across geographic location and industrial sector. The increase in carpooling is also consistent and almost wholly accounts for the decrease in the drive-alone share within every category. For example, the difference in the carpool share between service and manufacturing firms observed in the baseline data (Table

5) remains after the first year of implementation. Both service and manufacturing sites increased the carpool share by similar absolute amounts. The only exception to this consistency is an increase in transit use among downtown sites (as might be expected given service availability) and a slight decrease in transit use outside of downtown. There were also no significant relationships between mode choice changes and the size of the work force at the employment site, either singly or jointly with other site characteristics.

Use of incentives

The plan required by the SCAQMD of each employment site is essentially a mix of various incentives by which ride-sharing will be encouraged and commuting by single-occupant autos will be discouraged. It is instructive, therefore, to determine the mix of incentives included among the 1110 employment sites in the sample, and to determine whether or not any statistically significant relationship exists between the measured change in AVR and the presence of particular incentives. The data on incentives also was obtained from the Regulation XV site plans, and they are limited in several ways. First, Regulation XV requires that the entire plan be implemented by the end of the year, so the provision of plan incentives could have been phased in any fashion over the duration of the year. Second, the incentives are categorized by SCAQMD staff, and the categories were subjectively determined. Third, incentive descriptions are limited. For example, a carpool subsidy could be \$10 or \$50 per month, a prize could be a free lunch or \$100 and could be given every week or once per year. For these reasons, the reported incentives provide only a rough approximation of each plan's elements.

Table 8 lists the incentives offered by the sample sites in the initial and first year update plans, grouped by the SCAQMD's classification system. Numbers indicate the percent of sites offering the incentive. Most extensively offered incentives in initial plans include preferential parking for carpools and vanpools (67%), financial incentives for transit users (49%), prize drawings (48%) and a guaranteed ride home (47%). Average number of incentives per site in initial plans was 7.6, the average increased to 9.6 in the updated plans. Most prevalent incentives

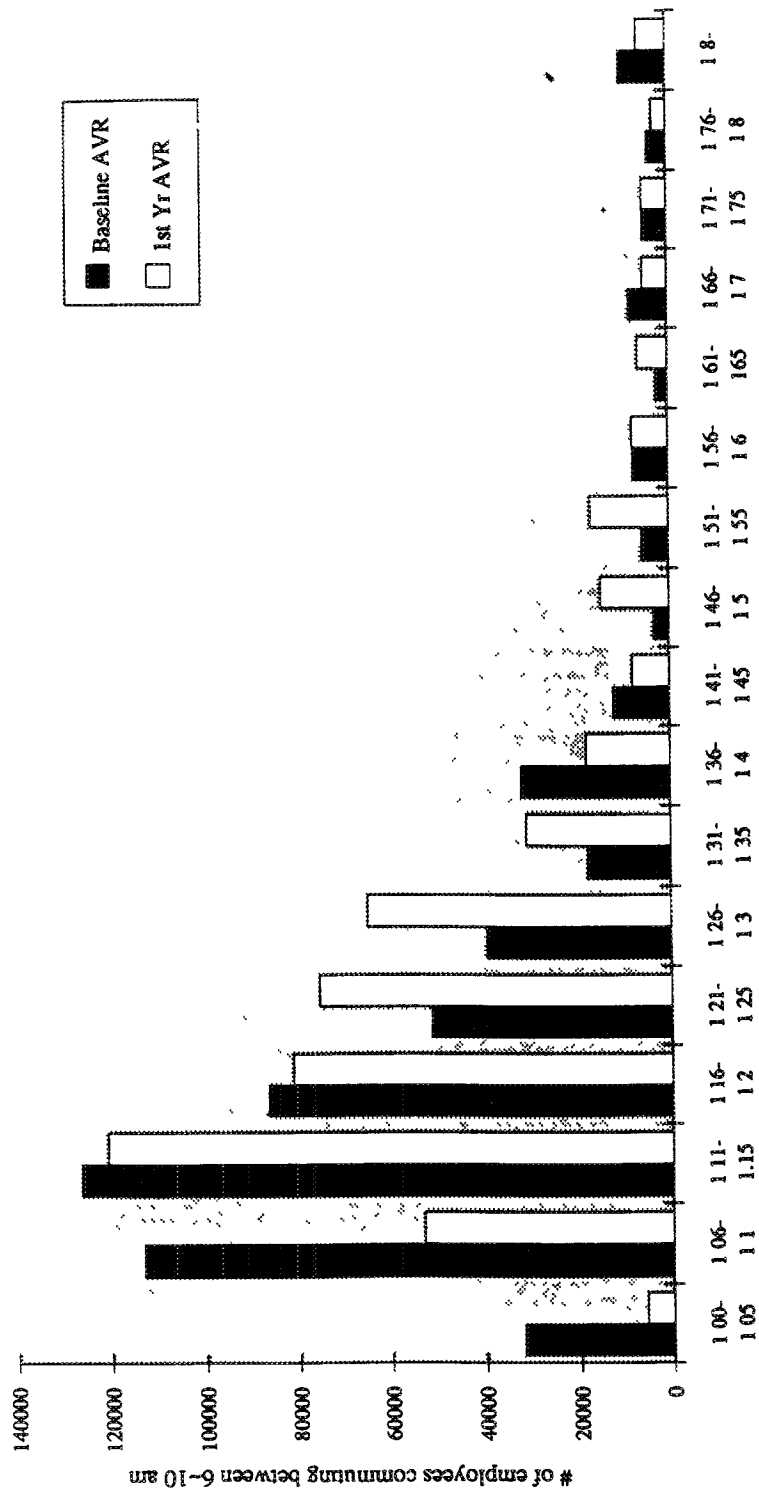


Fig. 4 Baseline and 1st year weighted AVR frequency distribution

Table 6 Change in AVR by AVR target

Target AVR	Mean Baseline AVR	Mean AVR after one year	% Change in AVR	N
1.75	1.421	1.481	4.2%	41
1.50	1.201	1.232	2.6%	102
1.30	1.155	1.190	3.0%	28

in the updated plans are guaranteed ride (75%), preferential parking (72%), financial incentives for transit users (68%) and prize drawings (65%). Since plan approvals are discretionary, SCAQMD has had the latitude to encourage specific incentives as well as the flexibility to raise the standards for acceptable plans over time.⁶ The guaranteed ride home is a good example of an incentive strongly supported by the SCAQMD. The prevalence of transit user financial incentives is largely explained by a recent Los Angeles City Ordinance that requires employers who offer free parking to also offer a \$15 per month subsidy on transit passes. It is important to note that the incentive is the *availability* of these options, rather than their use. Parking strategies are among the least prevalent incentives in both years, despite their strong support by the SCAQMD and the growing literature documenting their effectiveness (Willson and Shoup, 1990). Parking has emerged as a contentious local labor relations issue, and employers are apparently (and understandably) resistant to using such unpopular TDM strategies, despite pressure from SCAQMD.

We turn now to the question of whether the number or combination of incentives offered the initial plans has any statistical relationship with the change in AVR. We found that sites where AVR increased offered a larger number of incentives than sites where AVR decreased or remained unchanged (8.0 vs. 6.6 per site). We also found that the average number of incentives offered is inversely related to baseline AVR: sites with low baseline AVR offered more incentives than sites with high starting AVR. The number of incentives offered may be considered a measure of the intensity of the plan, and it seems reasonable that sites with baseline AVR furthest from the target would be inclined to develop more aggressive plans. These results complement our earlier observation that AVR increases are associated with low baseline AVR.

We conducted difference of means tests for each incentive to determine whether its availability in the initial plan was associated with increased AVR. We compared the average change in AVR between groups offering or not offering each incentive. A significant relationship was found for 11 incentives,

they are marked with asterisks in Table 8. These incentives include most of the mode-specific financial incentives, as well as guaranteed ride home and additional time off with pay—incentives that would be expected to have a significant impact. “Other employee benefits” include a variety of unique incentives, such as emergency road service, bicycle insurance and exemptions from tardiness penalties. The significance of recognition in the company newsletter suggests that travel behavior may be sensitive to factors beyond the cost and convenience of various modes. The significance of new hire orientation suggests that organizational culture or management objectives are also important, a finding documented in case studies of employer-based ride-sharing programs. In contrast, none of the parking strategy incentives, either individually or as a group, were significantly related to increased AVR, perhaps because of the small number of sites where these incentives were provided.

A further test of the effect of incentives is whether incentives oriented to specific modes are related to increases in the use of these modes. The greatest change took place in the carpooling share, we test whether the change in carpooling is related to the provision of the following carpool-oriented incentives: carpool financial incentives, guaranteed ride home, preferential parking and ride-matching services. The availability of financial incentives is highly significant: the average increase in carpooling at sites providing financial incentives was much greater than at sites without such incentives. The availability of guaranteed ride home was also significant, and the remainder were found to be not significant.

Preliminary results after 2 years

Our research also includes a sample of 243 worksites at which the regulation has been implemented for two full years. These worksites are the larger sites that were targeted during the first year of Regulation XV's implementation, and thus are not representative of the population of sites subject to the regulation. However, changes at these sites are likely suggestive of overall trends. Table 9 gives the change in AVR and mode shares after one and two years of implementation for this sample. Trends of the first year continue in the second: AVR increases by an additional 3.6%, and most of the increase can be attributed to further increases in carpooling. Vanpooling increased substantially, but continues to

⁶Average number of incentives per initial plan by year of approval are: 1988—7.0, 1989—8.2, 1990—

Table 7 Changes in mode share

Mode	Baseline	After One Year	% Change
Drive Alone (DA)	757	709	-6.3*
Carpool (CP)	138	184	33.3*
Vanpool (VP)	021	024	14.2
Bus (B)	032	032	0.0
Walk/Bike (W/B)	029	028	-3.4
Telecommuting (TEL)	006	005	-16.7
Compressed Workweek (CWW)	016	019	18.8

*Difference of Means Test significant at $p \geq .01$

Table 8 Frequency of incentives by types

Incentives	Percent of Sites	
	Initial Plan	First Update Plan
Commute-related Site Services		
preferential parking area	66.9	71.5
guarantee ride home**	47.3	74.5
bike racks	42.5	44.6
outside computerized ride-matching service	36.5	41.9
employer-based rider-matching	26.0	29.6
showers and lockers	21.5	25.7
facility improvement others**	3.2	5.0
passenger loading area	1.7	1.8
Mode Specific Money Incentives		
financial incentives for transit users**	49.0	67.8
financial incentives for carpoolers**	29.0	41.1
financial incentives for walkers**	18.6	31.7
financial incentives for biker**	17.7	30.0
financial incentives for vanpool users**	13.9	22.9
other financial subsidies	8.0	13.6
introductory transit subsidies	5.5	11.0
subsidized vanpool seats	3.6	5.9
Employee Benefit		
prize drawings**	47.7	64.8
other employee benefits**	23.4	36.4
company owned/leased vanpools	15.8	13.8
auto services	13.6	20.2
recognition in company newsletter*	12.8	16.1
additional time off with pay**	7.0	10.1
Site Service		
transit information, booths/bike racks	31.5	25.1
cafeteria, atm's, postal fitness center	19.0	23.0
other on-site services	16.0	19.9
childcare services	1.2	1.7
Alternative Work Hours		
flexible work hours	31.4	33.3
compressed workweek	21.4	30.8
telecommuting	8.8	13.1
Information and Marketing		
commuter information center	26.8	28.7
new hire orientation	25.5	30.7
other marketing elements	24.4	34.0
special interest group	12.7	11.5
commuter fairs	11.5	16.1
Parking Strategies		
parking price increase	3.0	3.1
subsidized parking for ride-sharers	2.4	4.5
other parking management strategies	2.1	4.6
transportation allowance	0.5	1.1

*Presence of incentive significantly related to greater increase in AVR, at $p < .05$

**Presence of incentive significantly related to greater increase in AVR, at $p < .01$

Table 9 Changes after 2 years of implementation, small sample

	Baseline	After One Year	After Two Years
AVR	1 216	1 258	1 304
Drive Alone (DA)	751	697	654
Carpool (CP)	142	194	231
Van (VP)	006	010	014
Bus (B)	039	038	044
Walk/Bike (W/B)	032	032	033
Telecommute (TEL)	005	003	003
Compressed Workweek (CWW)	025	027	022

$N = 243$

constitute a very small proportion for commute trips

CONCLUSIONS

Our analysis of Regulation XV's first year results shows that a significant increase in AVR occurred among worksites subject to the Regulation, and that this increase may be attributed to the TDM plans implemented as a result of the Regulation. Regulation XV had the effect of making more ride-sharing incentives available to more Los Angeles region commuters. Almost 70% of the sites experienced some increase in AVR, for half of the sites the increase was between zero and 10%. Increased AVR was associated with lower starting AVR, while decreases in AVR were associated with higher starting AVR. These results confirm prior studies that note that the basic ride-sharing market (long-distance commuters with moderate household income and/or limited auto access) can be exploited relatively easily. Preliminary results after 2 years suggest that AVR increases will continue.

We also found that the increase in AVR is almost entirely accounted for by an increase in carpooling. Not only do other modes have little impact because they are so little utilized, but with the exception of vanpools, their use did not increase to any significant extent. Transportation and ride-sharing agencies have heavily supported (and subsidized) vanpools, transit and telecommuting. Several vanpool subsidy programs are available to private companies, transit pass subsidies are aggressively marketed by the region's public transit agencies and several state-funded telecommuting demonstration projects are currently underway.⁷ It will be interesting to see whether the use of these modes will become significant in the future. From an employer's perspective, the emphasis on carpooling makes sense, as it is the least disruptive to existing organizational patterns and its marketing can easily be obtained via the regional ride-sharing agency or the region's numerous TDM consultants. In contrast, the development of vanpool programs or telecommuting requires more

organizational effort and could significantly impact productivity. From the employee's perspective, carpooling may be the most reasonable alternative to driving alone, given the dispersed development pattern of Southern California.

Regulation XV is a very ambitious attempt to change the travel behavior of Los Angeles region commuters. It is a critical element in the region's air quality improvement strategy. Increases in AVR are expected to translate to decreases in peak period VMT and air pollution. Given these objectives, it is appropriate to consider whether the AVR targets can be reached, and if they were achieved, whether the expected air quality benefits would follow. Although these early results are positive, they do not imply that the AVR targets will be reached. Prior research shows that higher than average ride-sharing rates typically require strong incentives and many years to develop. Most of the AVR improvement to date is the result of carpooling, close to two-thirds of the work force would have to carpool in order to reach a 1.5 AVR. Clearly, strong incentives (or disincentives) would be required to achieve modal shifts of such magnitude. A second issue is whether the anticipated air quality benefits would occur even if the AVR targets were achieved. Since the regulation ultimately applies to less than half of the work force, and since work trips make up less than half of all peak period trips, less than one fourth of all peak trips are affected. In addition, traffic congestion is so extensive in the region that the potential offsetting effects of latent demand may be significant. Thus, while vehicle occupancy might increase overall, congestion and air pollution may not be reduced at all. Finally, these results do not suggest that Regulation XV or other similar mandated trip reduction programs are necessarily either efficient or effective. More research is necessary on the regulation's costs and benefits, and on its indirect effects on commuters and employers, in order to assess its overall worth as a strategy for addressing congestion and air pollution problems.

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⁷For example, the City of Los Angeles will give a van to any company that can fill it with 12 people.

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