

**Suburbanization of Jobs
And the Journey to Work**

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Suburbanization of Jobs and the Journey to Work

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Abstract

In recent years, a debate has brewed over whether the decentralization of employment has been beneficial from a regional standpoint. In this article, we focus on one aspect of the debate: how the relocation of office workers from a downtown to a suburban location affects commuting behavior. From a survey of 320 former downtown San Francisco workers who now work in the suburbs, we found that the average distance traveled remains essentially unchanged and that the average commuting speed declines. The most dramatic change is the switch from public transit to private auto commuting. In the aggregate, we estimate that the change in job location is associated with nearly a threefold increase in vehicle miles traveled to work. While from a personal standpoint, employees seem to be better off since they get to work faster in a superior form of transportation, from a larger social and environment perspective, the costs could be significant. More detailed analyses of submarkets reveal that the transportation impacts vary considerably depending on whether the original residence was in the suburbs or central city and whether relocated workers have moved their residences in recent years. In general, those who remain in San Francisco and become reverse commuters are worst off whereas those who move their residences out of the city are much better off in terms of transportation access. The research also shows that, consistent with theory, movers tend to trade-off larger lot living for a longer commute, even when jobs suburbanize. The article concludes that various users charges, development fees, and transit service reforms are needed to respond to the rapid growth in suburban employment markets.

Suburbanization of Jobs and the Journey to Work
A Submarket Analysis of the San Francisco Bay Area

There has been a longstanding debate over whether decentralization is good or bad for cities. Early arguments centered on the decentralization of residences. Critics -- pejoratively referring to the phenomenon as "sprawl" -- maintained that the dispersal of housing to the suburbs and beyond would excessively raise infrastructure costs (Real Estate Research Corporation, 1974), prematurely consume valuable farmland (Peterson and Yampolsky, 1975), harm natural environments (Blumenfeld, 1968; Miller and Canty, 1971), sap urban districts of their vitality (Jacobs, 1961; 1984), and segregate classes of people (Downs, 1973; Lake, 1981). Others counterargued that decentralization has relieved central cities from overcrowding and other agglomeration diseconomies (Lessinger, 1962), is a market response to the high cost of central city living (Kaunitz, 1957), can be as energy efficient and environmentally conserving as dense urban growth (Altshuler, 1981), and can actually lower the cost of some public services, like fire protection (Muller, 1975). More recently, the debate has shifted to whether a subsequent phase of decentralization -- the suburbanization of employment -- has benefitted cities or not. This new debate has focused most centrally on the question of transportation impacts. While the migration of jobs to where more and more Americans live could be expected to shorten commute trips (Gordon and Wong, 1975; Gordon, et al., 1986; 1989; Pisarski, 1987), others have argued that this has been offset by a worsening jobs-housing imbalance (Cervero, 1989B) and the creation of an urban form that forces more Americans to switch their mode of commute from public transit to the private

automobile (Cervero, 1989A; Kelbaugh, 1989; Newman and Kenworthy, 1989). The debate, then, has come down to whether the decentralization of employment, in particular white-collar office jobs, has put more Americans closer to their workplaces, which everyone can agree is good; and whether decentralization has induced significant shifts from mass transit and other collective forms of travel to the drive-alone automobile, which might be good from an individual's standpoint, but which could impose significant social and environmental costs.

To date, the debate has remained largely conjectural because of the lack of sufficient data to trace the effects of office relocation on commuting behavior and traffic conditions. Most empirical work has relied on special travel surveys conducted by the U.S. Department of Transportation in 1977 and 1983 as well as the 1980 diennial census. Yet, most observers agree that the explosive growth in suburban employment has been a post-1980 phenomenon -- in 1980, 57 percent of all office space in the U.S. was located in urban centers and 43 percent was in the suburbs; by 1986, the situation was reversed -- 60 percent was in the suburbs, compared to 40 percent in cities (Office Network, 1987; Cervero, 1989A). While journey-to-work statistics from the 1990 census will tell us how average commute distances and modal shares have changed, it could be several years before such statistics are available in published form.

This article aims to resolve some of the debate on the transportation impacts of job decentralization using empirical data from the San Francisco Bay Area. In particular, the study focuses on how commuting distances and speeds as well as modes of travel have changed for 320 office workers whose jobs relocated from downtown San Francisco

to a suburban location during the 1987-1989 period. We believe that simply comparing commuting choices before and after the job move, however, oversimplifies the analysis. however. In order to provide a more complete picture of how job relocations influence commuting choices, we present a submarket analysis as well. Here, we stratify the analysis of impacts into several subgroups of workers whose homes were previously in the suburbs versus in San Francisco as well as those who did and did not move their residences during the period their jobs left downtown. Besides providing a richer perspective, such a breakdown also offers more useful insights into the transportation policy implications of job decentralization.

Several prior studies have traced the effects of office decentralization on the commuting characteristics of workers, however past work has largely concentrated on experiences in England (Wabe, 1967; Daniels, 1972, 1981) and Canada (Ley, 1985). Even these works produced conflicting results. In his study of office relocations in the greater London area, Daniels (1972) found that most employees experienced a longer commute after their employer relocated to the suburbs because most workers chose not to disrupt their family living situations by also relocating their residences. He also documented a dramatic switch in commuting modes, from public transit to the private automobile. Daniels (1981) found, moreover, that these were not just short term effects and indeed held over long run. In contrast, Wabe (1967), O'Connor (1980), and Ley (1985) each found average commuting distances fell after firms moved to the suburbs, and that those hired after the relocation experienced the shortest commutes. Suffice to say, based on past research some uncertainty remains regarding the transportation

implications of decentralized office growth.

Data Source

From a questionnaire, information was compiled on the commuting and residential location characteristics of 320 office workers whose jobs relocated out of downtown San Francisco to one of three suburban employment locations in the Bay Area during the three year period from January 1987 to December 1989. Over 90 percent of the relocations were to the two employment sites in southern Contra Costa County and the remainders were to the single site in northern Santa Clara County, known as the Silicon Valley. In all, a response rate of around 60 percent was secured from the original questionnaires sent out.¹ The survey asked retrospective questions on where workers lived and how they commuted prior to their job relocation as well as presently (which was defined as time when the survey was completed, which for everyone was during the September to December 1989 period). Thus, a before and after portrait on commuting distances and mode choices could be drawn from survey responses.

The 320 survey responses were gathered from workers at three different firms who had been relocated to three different job sites outside of San Francisco. Figure 1 maps the locations of these firms. Among the sites, work forces ranged in size from 1,600 to 6,000 employees. These are among the biggest and wealthiest employers in the Bay Area, conducting business in the fields of electronics, communications, petroleum production, computers, and public utilities. For all companies, their suburban location supports various back office and support functions, like financial management, research and development, and product billing. Most of the survey respondents were professionals

earning fairly high salaries. In all, 48 percent were executive managers, 41 percent were in professional or technical occupations, and the remaining 11 percent had mainly clerical, secretarial, sales, and service jobs. This is a much higher share of professionals and managers than found in suburban employment centers in the Bay Area suburbs, which for the Interstate-680 corridor in southern Contra Costa County (which includes the two main suburban sites studied) was estimated to be 23 percent in 1986.² The average annual salary of each respondent was \$50,600, much higher than Bay Area's average. Respondents were split nearly evenly between males and females. Over 70 percent were white. The average age was just under 40. Thus, the typical respondent could be viewed as a middle age executive working for one of the largest companies in the Bay Area and earning a relatively high salary who had been relocated from downtown San Francisco to a suburban location over the latter part of the 1980s. Thus, these research results must be interpreted with respect this select subset of suburban office workers and do not necessarily hold for others, notably clerical workers and other non-professionals.

In general, all surveys stand the risk of producing biased results since they rest on peoples' perceptions rather than actual, measured behavior. For instance, before and after data on journey-to-work distances were compiled from a question which asked: "what is your home-to-work travel distance (in miles, one-way)?" It is unlikely that many respondents had studied their odometers closely enough to give a precise answer. Quite perceived and actual distances varied for most. Moreover, even though information was requested for "one-way" distances, based on some of the responses, it appears that some

filled in two-way daily distances. Additionally, while the survey asked for "travel distance", some might have estimated straightline distance. If such biases did occur, they likely cut across the survey responses. Since this analysis focuses on proportional differences in travel behavior before and after the job relocation, such biases should not affect the analysis as long as they are more or less of similar magnitude for the "before" and the "after" periods.

Overall, the use of before and after data provides a good study design for tracing the impacts of office relocations since the same individuals are examined at both time points. As with a panel study, such data allows other factors, like gender and occupation, to be controlled for.

Overall Effects of Office Relocation on Journey-to-Work

Figure 2 summarizes changes in average commute distances, travel times, and mode splits for all 320 surveyed workers. Overall, there is little change in commute distances, with the average falling only slightly from 25.4 miles when the workers were downtown to 25 miles when their jobs were relocated to the suburbs. In general, average commutes are long for downtown workers because of the existence of a large bay in the middle of the region, which adds considerable miles for those who reside in the East Bay and other locales outside of San Francisco. It is expected that the distances are somewhat inflated as well because some respondents likely recorded two-way daily distances, despite the fact that one-way distances were asked for. Again, since our interest lies with comparing changes in distances, as long as those who recorded two-way distances did so for both before and after their job relocation, the relative differences in

home-work distances should be unaffected. Overall, it appears that there has been relatively little change, with employees presently residing, on average, about the same distance from their workplace as before the job relocation.

In terms of travel times to work, the figure suggests that employees are generally getting to work much faster after the relocation than before. Since average commute distances have remained essentially unchanged, one can infer that average commute speeds have fallen by around 30 percent following the move. This likely reflects both the fact that, as discussed below, substantial numbers of workers are switching over from mass transit to the faster private automobile and major suburban roads tend to be less congested than roads within and serving San Francisco.

By far, the greatest change in travel has been with respect to mode. When their offices were in San Francisco, only 22.8 percent of the respondents drove to work alone; after their jobs relocated to the suburbs, the share jumped to nearly three-quarters. Accordingly, the share taking rapid transit (BART) or buses to work plummeted from 58.1 percent to just under 3 percent. In general, when jobs relocate from dense urban centers to low density suburban environs, the collective forms passenger travel appears to switch from traditional mass transit to much smaller scale carpools and vanpools. Basically, privately coordinated pooling appears to be replacing publicly provided mass transit when origins and destinations are scattered across the map.

Overall, then, moving office workers from downtowns to suburbs appears to be associated with a dramatic changeover in commuting from public buses and rail cars to private automobiles. From a personal standpoint, the commuter appears to be better off

when jobs relocate to the suburb -- he or she is getting to work much faster and in a superior, far more flexible, and usually more comfortable form of transportation. From a larger social and environmental standpoint, however, the impacts could be detrimental. Since, from the survey, average commute distances did not change, yet the number of vehicle trips generated by the switchover of workers from mass transit to individual automobiles rose dramatically, overall the relocation of offices to the suburbs has been associated with a dramatic increase in vehicle miles travelled (VMT). Assuming that the average carpool/vanpool carries 5 passengers and the average mass transit vehicle carries 50 passengers during commute hours, we estimate that VMT rose nearly three times for these 320 workers following the suburbanization of their jobs.³ Since energy consumption and tailpipe emissions are directly related to VMT, one could assume that the Bay Area as a whole is worse off, environmentally, whenever jobs relocate out of San Francisco. To the extent that the changeover to private automobile leads to increased suburban traffic congestion and creates inequities between those who drive and those who do not have access to cars, the social and economic costs could be even more substantial.

Submarket Analysis

In this section, we stratify the analysis by different subgroups of workers, depending on whether their residence at the time of job relocation was in San Francisco or another location and whether they moved their residence within three years of when their offices relocated. In all, five submarket analyses are presented below.

Suburban Workers Whose Residences Remain in the Central City

This first subgroup is those San Franciscans whose jobs left the city but who

retained a San Francisco home address. Thus their journey-to-work switched from an inner-city commute to a reverse (city to suburb) commute. Figure 3 shows that in virtually every respect, these workers are worse off. Following job relocation, the average commute distance increased 477 percent and average travel times rose by 75 percent. Since travel times rose far less than distances, this means that those who found themselves reverse commuting once their jobs left the city were traveling at significantly faster speeds than before. The lower half of the figure shows that the drive-alone shares also rose sharply, though less so than for the aggregate 320 employees surveyed. Those entering the reverse commute market also switched over rather dramatically to carpooling/vanpooling. On the transit side, whereas most in this subgroup previously took buses, trolley cars, light rail trains, cable cars, and other forms of mass transit available within San Francisco to work, following the change in workplace transit's modal share dropped off sharply. While low, it is noteworthy that the share of commute trips by both transit and ridesharing is the highest for this subgroup than any of the others. Apparently, factors like the high cost of owning a car in San Francisco, the familiarity of most city residents with using mass transit, and perhaps the generally high quality of BART rail services in the reverse commute direction (e.g., seats are usually available) have encouraged a relatively large share of suburban office workers who reverse commute to opt out of driving alone to work.

Among all of these subgroups studied, these new reverse commuters appear to be the worst off as a consequence of job relocation, reflected most by the dramatic increases in travel times and distances. Ethnically, this subgroup is one-quarter Asian, 12.5 percent

Hispanic, and 56.3 percent white (as compared to 13.3 percent Asian, 8.4 percent Hispanic, and 71.5 percent white among all 320 persons surveyed). Thus, those disadvantaged by job relocation appear to be disproportionately made up of ethnic minorities who, for whatever reason, have chosen to maintain a San Francisco residence. This subgroup is also made up of those with relatively unstable positions and jobs -- between 1987 and 1989, the average number of positions held was 3.2, the average number of companies worked for was 1.5, and the average number of workplace locations was 3.3. Given such rapid turnover rates in jobs, positions, and work locations, it is not surprising that this group has chosen to retain their residences in San Francisco rather than try to move closer to their job sites.

Suburban Workers Whose Residences Remain in the Suburbs

This submarket consists of those whose jobs have relocated from San Francisco to a suburban location and have retained their suburban residence since the change in work site.⁴ Thus, their commute pattern has changed from a traditional downtown-oriented radial trip to an intrasuburban commute. Figure 4 shows that their average commute distance has fallen slightly and, because of their greater use of the private automobile and less congested suburban thoroughfares, their average travel times have fallen even more dramatically. In general, it appears that just because a job suburbanizes does not necessarily mean that a significant number of those already living in the suburbs will enjoy shorter commutes, at least distance-wise. Modally, workers in this subgroup appear to become heavily auto-reliant once their jobs migrate out to the suburbs.

Overall, those switching from a downtown-destined to an intrasuburban commute

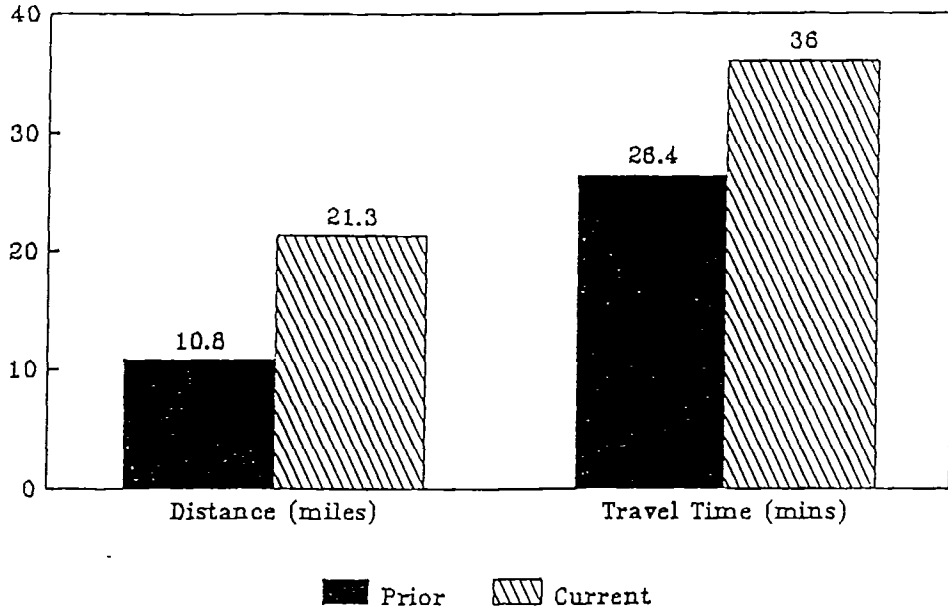
appear be better off as a result -- they're logging fewer miles each day, getting to work faster, and taking a superior form of transportation. Environmentally, however, the switch from transit to auto commuting, and the resulting increase in VMT, suggests that the Bay Area suffers from more emissions and greater energy consumption as a consequence. Demographically, this submarket can be characterized as being slightly older, better paid, owning more vehicles, and enjoying a higher incidence of home ownership than the typical worker whose job relocates to the suburb.

Suburban Workers Who Relocate Residences to the Suburbs

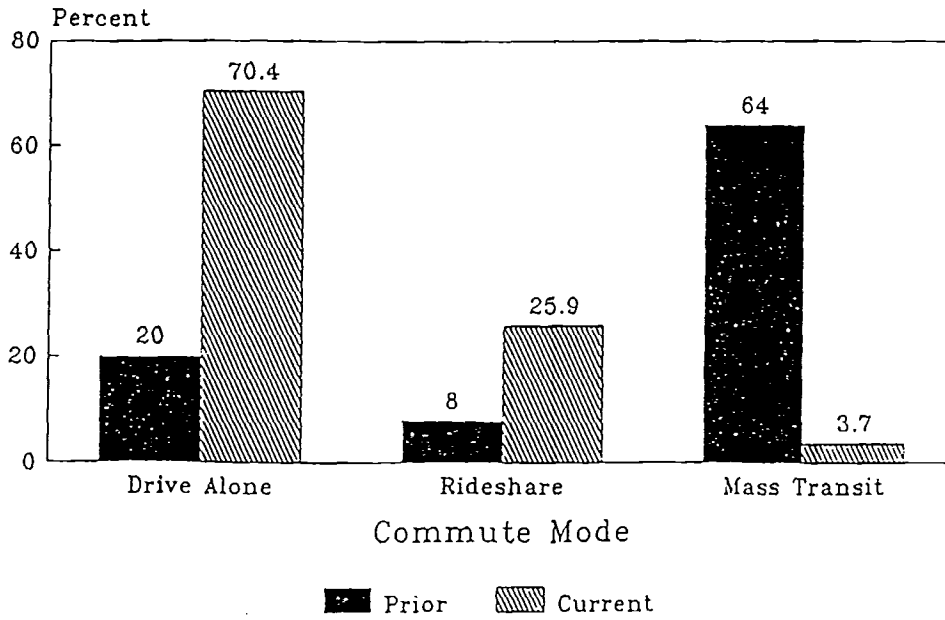
Included in this submarket are those who followed their jobs by moving their residences from San Francisco to a suburban location. These are office workers, then, whose journeys to work changed from an intraurban to an intrasuburban commute.

Figure 5 shows that average home-work distances nearly doubled, on average, for this group. Such a difference can partly be explained by the relative compactness of residential living in San Francisco which produces fairly short intraurban commutes.⁵ It also, however, possibly reflects the fact that a number of forces, be they inaffordable housing near job sites, preference for large lot living, or exclusionary factors, are resulting in a sizeable share of former San Francisco residents to end up in residences that are relatively far from their job sites.

The relationship between travel times and mode splits is unique for this group. Whereas for the others, the average travel time and levels of transit use tend to fall once jobs suburbanize, for this group the decline in mass transit is associated with substantially more time consuming commutes. Still, average speeds fall for those who switch from



Change from a CC-CC to S-S Commute



Change from a CC-CC to S-S Commute

Figure 5. Average commute distance, time, and modal split characteristics of downtown workers who relocated to a suburban employment site and also moved their residence from San Francisco to a suburb (N=38)

intraurban to intrasuburban commuting, owing to the greater use of private automobiles and freeways. The lower half of the figure also reveals that ridesharing becomes an important means of transportation for this submarket.

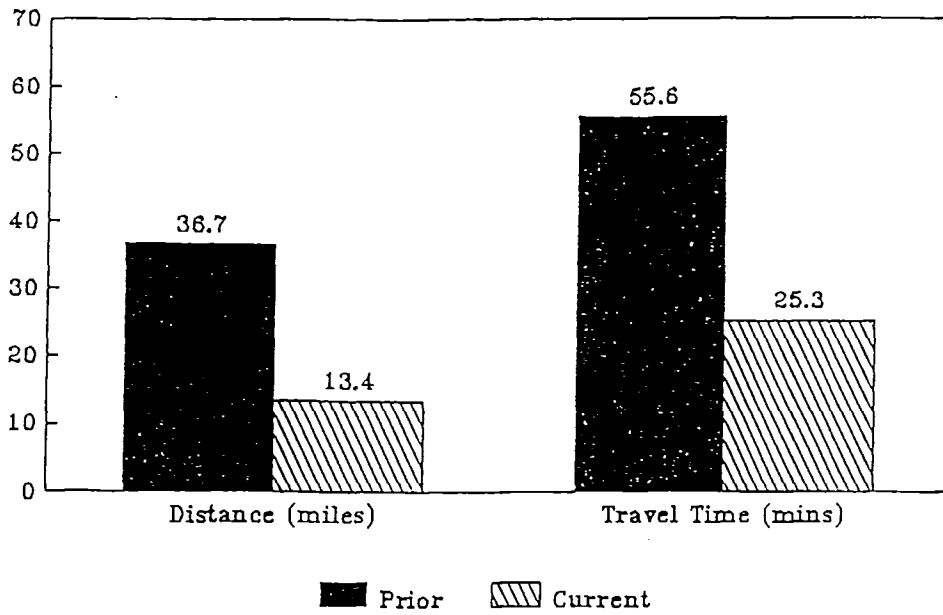
Suburban Workers Who Relocate Residences Within the Suburbs

This submarket is made up of those who lived in a Bay Area suburb prior to their job relocating out of San Francisco but who have subsequently moved their residence to another suburban location. Thus, their work trips have changed from a radial suburb-to-downtown to a suburb-to-suburb commute.

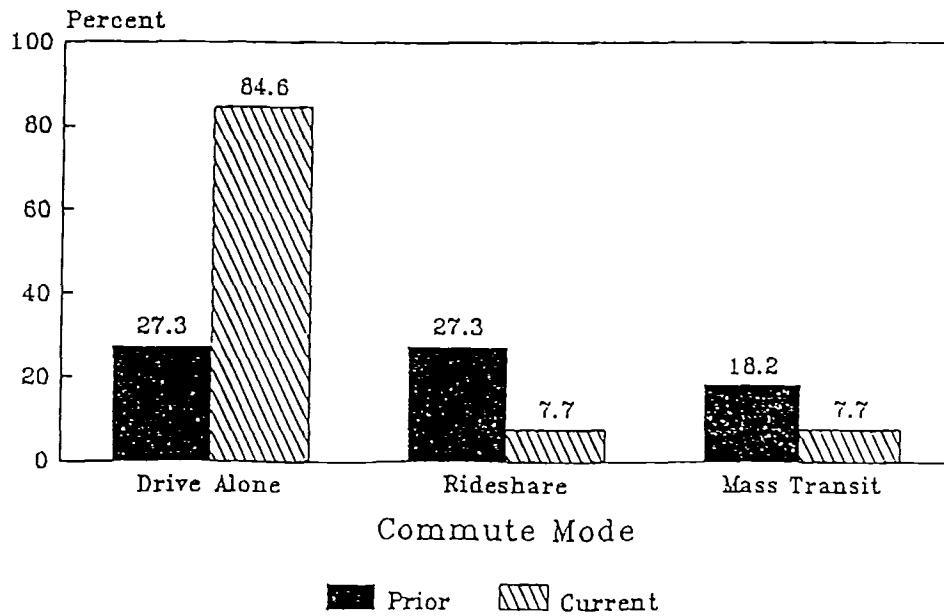
Figure 6 reveals that workers in this submarket enjoy a shorter commute, both time and distance wise, following their change in both workplace and residence. This group, moreover, averages a shorter commute than those who relocate their residences from San Francisco (Figure 5). The share of drive-alone trips made by this group following job relocation is the highest among all submarkets. Conversely, both ridesharing and transit commuting are the least popular among this group.

Those Whose Jobs Have Been in the Suburbs and Only Recently Moved

A final subgroup that was looked at was those whose jobs were in the suburbs prior to 1987, and thus have historically been suburban workers, and who have only recently moved their residences from San Francisco to a suburban locale. While this group does not quite fit the pattern set so far in the sense that some have possibly never worked downtown, it does represent a unique submarket of moving patterns that adds an interesting perspective to this research. In terms of the journey-to-work, this group has switched from a reverse to an intrasuburban commute pattern.



Change from a CC-S to S-S Commute



Change from a CC-S to S-S Commute

Figure 7. Average commute distance, time, and modal split characteristics of those who have worked in the suburbs since 1987 and more recently moved their residence from San Francisco to the suburbs (N=33)

Figure 7 shows that both commute distances and travel times tend to fall sharply once long-time suburban workers move out of the central city. In fact, the decline in commute distances and travel times was greatest for this submarket than any other. Interestingly, home-work distances and travel times are far shorter for long-time suburban workers who only recently moved to the suburbs versus those whose jobs and residences recently suburbanized (shown in Figure 5). For the former group, the average home-work distance is currently 13.4 miles compared to 21.3 miles for the latter. In addition, while long-time suburban workers have switched en masse to solo-commuting, they still patronize transit proportionally more than other subgroups. One can surmise that those whose jobs have historically been in the suburbs are moving their residences so as to be relatively near and transit accessible to their job sites. Whether this is a result of certain locational advantages they enjoy or the inability of other suburbanized households to reside as close to work as they would like, either because housing is too expensive or because of exclusionary barriers, can only be speculated.

Factors Influencing Home-Work Distances

To examine what demographic and background characteristics are associated with journey-to-work distances among subgroups of workers, a series of stepwise regression analyses were performed. The intent here is to account for factors that are associated with workers, whose jobs have recently suburbanized, living relatively close versus relatively far from their job sites.

Those Whose Jobs Have Suburbanized and Moved Residences

The first analysis was performed on those whose jobs relocated out of San

Francisco during the 1987-1989 period and who likewise moved their residences over the same period. Table 1 presents the stepwise regression results from correlating journey-to-work distance with a number of demographic, occupational, and attitudinal variables compiled from survey responses for this group. The table shows that, in general, longer home-work distances are experienced by those in professional /management positions who have high vehicle ownership rates and tend to solo commute and for whom the cost of housing weighed heavily in their decision to move to their new residential location. Because of their relatively high professional and auto ownership status, it would appear that those moving their residences, perhaps partly in response to the suburbanization of their jobs, are not being forced to live far away because they are being priced out or excluded from housing markets near their workplaces. Rather, the model suggests that these workers are choosing to reside farther away, perhaps taking advantage of the easier commutes afforded by being in the suburbs and consuming more lower priced housing on the metropolitan periphery. This finding appears consistent with what the traditional monocentric model of urban location theory says higher income people prefer -- to trade-off longer commutes for larger-lot, single family housing (Kain, 1962; Alonso, 1964).

Submarket Analyses

Reasonably good fitting regression equations were only fitted for two other submarkets of jobs and residence movers. One was those whose jobs suburbanized during the 1987-1989 period and who over the same period also relocated their residences within the suburbs. Table 2 shows the stepwise regression results for this submarket. The table shows that, within this group, home-work distances are the

TABLE 1. Stepwise regression results on factors influencing home-work distances for workers whose jobs have suburbanized and who have also moved residence

Dependent Variable: DISTANCE

Variable	Beta coefficient	Standard error	t statistic	Probability
HOME COST	3.57	0.98	3.63	.001
VEHICLES	7.60	2.69	2.82	.006
DRIVE ALONE	10.53	4.62	2.27	.026
OCCUPATION	10.61	6.07	1.74	.085
Constant	-4.51	9.32	-.48	.629

Summary Statistics:

Number of observations = 87
R-Squared = .237
F Statistic = 5.61
Probability = .001

Variable Definitions:

DISTANCE = Home-Work distances (oneway, in miles).
HOME COST = Ordinal rating of the importance of cost of home in their decision to move from their previous residence to their present one, where 1 = not important and 5 = most important factor.
VEHICLES = Current number of crs, light trucks, and vans in household.
DRIVE ALONE = Current mode of commute to work, where 1 = drive alone auto and 0 = all other modes.
OCCUPATION = Current occupation, where 1 = executive/manager or professional/technical and 0 = all other occupations.

TABLE 2. Stepwise regression results on factors influencing home-work distances for first submarket: those whose jobs have suburbanized and who have also moved their residence within the suburbs

Dependent Variable: DISTANCE

Variable	Beta coefficient	Standard error	t statistic	Probability
NEIGHBOR	3.86	1.86	2.07	.043
VEHICLES	5.86	3.12	1.87	.066
DRIVE ALONE	-10.53	5.69	-1.82	.074
Constant	1.22	11.43	0.11	.915

Summary Statistics:

Number of observations = 59
R-Squared = .164
F Statistic = 3.51
Probability = .021

Variable Definitions:

DISTANCE = Home-Work distances (oneway, in miles).
NEIGHBOR = Ordinal rating of the importance of quality of the neighborhood in their decision to move from their previous residence to their present one, where 1 = not important and 5 = most important factor.
VEHICLES = Current number of cars, light trucks, and vans in household.
DRIVE ALONE = Current mode of commute to work, where 1 = drive alone auto and 0 = all other modes.

TABLE 3. Stepwise regression results on factors influencing home-work distances for second submarket: those whose jobs have been in the suburbs since 1987 and who have recently moved their residence from San Francisco to a suburb.

Dependent Variable: DISTANCE				
Variable	Beta coefficient	Standard error	t statistic	Probability
LARGE HOME	7.91	1.26	6.28	.003
SCHOOLS	-5.64	0.67	-8.39	.001
VEHICLES	6.89	1.23	5.59	.005
DRIVE ALONE	20.32	2.72	7.45	.001
Constant	9.25	4.11	2.25	.087

Summary Statistics:

Number of observations = 17
R-Squared = .953
F Statistic = 20.25
Probability = .006

Variable Definitions:

DISTANCE = Home-Work distances (oneway, in miles).
LARGE HOME = Ordinal rating of the importance of living in a large size home in their decision to move from their previous residence to their present one, where 1 = not important and 5 = most important factor.
SCHOOLS = Ordinal rating of the importance of residing in a good school district in their decision to move from their previous residence to their present one, where 1 = not important and 5 = most important factor.
VEHICLES = Current number of cars, light trucks, and vans in household.
DRIVE ALONE = Current mode of commute to work, where 1 = drive alone auto and 0 = all other modes.

greatest for those from households with relatively high levels of vehicle ownership (perhaps serving as a proxy for income), yet who are most inclined to participate in a carpool or vanpool. Hypothetically, the model says that someone whose job has recently relocated to the suburbs and who has also recently moved their residence within the suburbs could be expected to commute 21.7 miles to work if they came from a household with two vehicles, normally vanpooled to their office, and considered the overall quality of neighborhood to be the most important factor in choosing their home site. The positive correlation between long distance commuting and vanpool usage in suburban labor markets conforms with other research findings (Cervero and Griesenbeck, 1988). In general, vanpooling and carpooling only become attractive over long distances since the benefits of having someone else drive and picking up others en route are only appreciable over a relatively lengthy journey.

A second submarket for which regression results were revealing were those whose jobs have historically been in a Bay Area suburb but who have only within the last three years relocated their residence outside of San Francisco. Table 3 shows that, for this group, long home-work distances are most common among workers from households owning a relatively large number of vehicles (again, an income proxy), who generally solo-commute, and who placed a high premium on finding a large home and a low premium on being in a good public school district when they choose a site. Consistent with the other regression models, it appears that better-off suburban office workers whose jobs moved out of downtown San Francisco are willing to trade-off longer commutes for better housing.

Conclusion

With regards to the on-going policy debate over whether decentralization of jobs benefits or hurts cities, this research suggests that it really depends on which submarket one is referring to. Overall, before and after data on commuting behavior of 320 San Francisco workers whose jobs left the city suggest that average commute distances changed very little, however travel times tended to decline noticeably. The biggest change, however, was with reference to mode choice. When working downtown, 58 percent of the respondents indicated they commuted by some form of mass transit. With their jobs now in the suburbs, transit's market share has plummeted to a mere 3 percent. Thus, at least in the case of the San Francisco Bay Area, the suburbanization of employment appears to have resulted in workers commuting roughly the same distances at faster speeds and switching from a predominantly mass transit mode to an almost exclusive drive-alone mode.

This research has also shown that aggregate numbers like these oversimplify matters. Each of the submarkets studied was distinct and offered a unique perspective on the problem. From an individual mobility standpoint, those who appear to be best off are those who have historically worked in the suburbs and have only recently relocated their residence there. Worst off appears to be those whose jobs have suburbanized but have remained in the central city. These individuals average much longer commutes as a consequence.

While the submarket analysis offers a far richer perspective into how job decentralization impacts commuting, one can conclude that in the aggregate, the

suburbanization of jobs has been positive from a personal mobility standpoint. In general, workers tend to get to work faster by a more comfortable and convenient form of transportation once their job suburbanizes. From a larger societal perspective, however, the dramatic switch to auto commuting could engender substantial costs, including increased energy consumption, more tailpipe exhausts, and, to the extent that jurisdictions are unable to respond to new suburban traffic demands by building adequate highways, potentially greater suburban congestion. Our challenge must be one of getting suburban developers, employers, and individual motorists to internalize more of the external costs that their choices impose on society. In the case of developers, impact fee programs and performance standards need to be set to pass on the true environmental costs of their projects, particularly in the case of low-density office parks that create high levels of auto dependency (Cervero, 1989A). Only then will a built suburban form evolve which encourages workers to commute by something other than the drive-alone automobile. More and more employers should also be held accountable to mandatory trip reduction targets, such as those currently being enforced in Los Angeles and in Alameda County, California. And in the case of motorists, parking fees and other user charges must be levied to reflect the broader social and environmental costs of commuting alone.

It is important that such initiatives also be followed up by delivering a respectable alternative to the drive-alone automobile for suburban workers. This would most likely happen if more cities deregulated their paratransit markets, encouraged healthy competition within the mass transit sector, and shelved current plans to build expensive

fixed rail systems, channeling public funds instead into projects like exclusive busways. In general, mass transit systems of the future must be flexible, both route-wise and schedule-wise, to compete with the private automobile. Fortunately, a number of flexible forms of mass transit services have emerged in recent years that could serve as role models for suburban locales. These include the dedicated busway systems of Ottawa (Canada) and Houston, the dual-mode transit systems of Essen (West Germany) and Adelaide (Australia),⁶ and the timed-transfer transit operations in Edmonton (Canada) and Seattle (wherein bus runs are timed and routed to converge on designated transit centers at the same time, thus facilitating transfers). Rather than adapting mass transit to traditional low density settings, another alternative could be to design suburban workplaces and residences so that they are clustered together in moderately dense, mixed-use centers that are fed by fixed rail transit. Satellite centers like Farsta and Vallingby outside of Stockholm, Albertslund outside of Copenhagen, and Scarborough and North York outside of Toronto stand as testaments to ability of clustered, mixed-use suburban workplaces to attract well over one-half of their workforces into transit vehicles for the journey to work (Thomson, 1978; Goldsack, 1982; Pill, 1983). Charging motorists considerably more for motor fuel, vehicle registrations, and parking have been essential to transit's success in other countries (Pucher, 1988; Newman and Kenworthy, 1989). In general, removing hidden subsidies to solo-commuters, combined with public initiatives that penalize developers who build overly auto-dependent workplaces and reward those who do otherwise, would give rise to a built form and the kinds of mass transit services that would be environmentally beneficial over the long run.

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NOTES

1. This research is drawn from a subset of responses from a larger survey of 4,200 suburban and downtown employees in the Bay Area. Overall, 2,527 questionnaires were returned for a response rate of 60.2 percent. Because of the confidential nature of the data collected, we first met with company officials for the chosen firms to secure their approval to participate in the study. A draft questionnaire was designed and sent to officials from one of the companies for their review. Based on comments received, the questionnaire was revised and pretested. Once the final questionnaire was prepared, it was delivered to either the personnel office or some other coordinating office within the company where it was distributed in-house, generally to every worker within several divisions or departments. Respondents were then asked to return completed surveys in pre-addressed, stamped envelopes. Callbacks were made to secure as high of a response rate as possible.
2. Estimated from the U.S Bureau of Census data tape on 1986 County Business Patterns.
3. Before the relocation, the amount of VMT, adjusted for average occupancy,

produced among the vehicles used by the 320 workers is estimated as: $310 \text{ workers} \times [(.228 \text{ drive-alone}) \times (.169 \text{ shared-rides}/5 \text{ persons per vehicle}) \times (.581 \text{ mass transit}/50 \text{ passengers per vehicle})] \times 50.8 \text{ average daily round trip miles} = 4,445 \text{ VMT}$. After the relocation, the VMT per person produced among the vehicles used by the 320 workers is estimated as: $320 \text{ workers} \times [(.749 \text{ drive-alone}) \times (.215 \text{ shared ride}/5 \text{ passengers per vehicle}) \times (.028 \text{ mass transit}/50 \text{ passengers per vehicle})] \times 50 \text{ daily round trip miles} = 12,681 \text{ VMT}$. Dividing 12,282 VMT by 4,131 VMT yields a value of 2.85, suggesting that workers are generating nearly three times as much VMT after the job relocation. To the extent that mode switches were from electrically powered BART rail cars to fossil fuel powered automobiles, the energy consumption impacts could be even larger. Moreover, since many suburban workers rely on their cars heavily for midday trips to restaurants, banks, and other destinations at many suburban locales whereas most downtown workers walk to such destinations (Cervero, 1989A), the total differences in VMT (for both work and non-work trips) are likely far greater.

4. In this study, the suburbs are defined as a non-central city location -- specifically, any location outside the cities of San Francisco, Oakland, Berkeley, and San Jose.

5. The average commute distance of 10.8 miles for workers who both lived and worked in San Francisco seems unusually long given the fact that the city itself is only 49 square miles in size. Based on an inspection of individual survey results, this inflated distance is felt to be a result of some respondents reporting two-way rather than one-way distances. Since those reporting two-way distances did so for both before and after the job relocation, the relative differences in distances should be unaffected by these inflated

figures.

6. Dual-mode refers to vehicles that can operate like trains on a fixed guideway and also like buses on surface streets. Typically, they operate by dual propulsion as well -- by electricity while on the guideway and by diesel motor while on streets.

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