Analysis of Suburb-to-Suburb Commuter Rail Potential: Metrolink in Southern California

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As urban regions continue to decentralize, most travel growth occurs in suburb-to-suburb markets, lessening the relative importance of suburb to central business district (CBD) commuter rail lines. To remain viable in the longer run, commuter rail services need to tap at least some of the growing suburban markets, but it is unclear whether demand exists for suburban-oriented commuter services. The market for suburb-to-suburb commuter rail services is addressed. The potential number of work trip riders between every pair of stations of two Los Angeles area commuter lines operated by Metrolink is determined. Using the actual patronage between each pair of stations, a ratio of actual to potential riders, which indicates market penetration, is computed. The ratio is cross-classified by distance and by suburb-to-suburb or suburb-to-CBD status. Results suggest that short-distance suburb-to-suburb markets have considerable potential but negligible penetration; long-distance suburb-to-suburb markets have much smaller potential but surprisingly large penetration, though neither is as large as for suburb-to-CBD markets. The results suggest that commuter rail lines that serve edge city–type developments could generate substantial traffic.

This paper examines the relative strengths of suburb-to-suburb commute markets inadvertently served by two new regional rail commuting lines (Metrolink) in the polycentric Los Angeles basin. Patronage potential and the depth to which the potential is tapped in such markets are compared with potential and market penetration of more traditional suburb-to-downtown Los Angeles markets. The purpose is to gain insight into the question of whether public policy should attempt to encourage the expansion of commuter rail service into more suburb-to-suburb markets, where most growth in metropolitan travel has occurred in the past half century.

Background

As urban regions continue to decentralize, most travel growth occurs in suburb-to-suburb markets. As early as the 1920s, jobs began leaving central business districts (CBDs) to follow middle class residential dispersion originally facilitated by streetcar expansion and set up smaller centers in suburbia (*1,2*). Convenience retail, manufacturing, wholesaling, and by World War II large-scale specialty retailing continued the trend to the newest and ever-more-distant suburbs. For years only finance, insurance, and real estate jobs appeared immune from the decentralization trends, but in the 1980s even many of these activities moved to the suburbs. Over a 5-year period in the early 1980s, the percentage of national office space located in downtowns areas declined from 57 percent to 42 percent as up to 90 percent of all new office construction took place in suburbs (*3*). By the beginning of the 1990s, larger metropolitan regions were characterized by suburban centers, now known as edge cities, containing specialty retail, high-rise office buildings, hotels, movie houses, and even theaters, each rivaling or surpassing CBDs in magnitude of employment and activities offered (*4,5*). Not surprisingly, most of the spectacular growth in automobile travel since World War II, and particularly during the past decade, took place in the suburban arena and consisted of traffic that both began and ended in the suburbs (*6–10*).

Such demographic changes lessen the relative importance of suburb-to-CBD commuter rail lines, even though absolute patronage may increase. Whereas commuter rail ridership has been increasing on a nationwide basis, and even has been growing faster than bus transit patronage, as a percentage of metropolitan travel it has been declining (*8,11*). The Urban Mass Transit Administration (now Federal Transit Administration) Section 15 data indicate that in 1982 rail rapid transit carried 8.6 billion passenger miles, increasing to 12.0 billion in 1989. Streetcars carried 0.4 billion passenger miles in 1982, rising to 0.5 billion in 1989. Commuter rail carried 6.5 billion passenger miles in 1985, rising to 7.2 billion in 1989. Motor buses carried 19.1 billion passenger miles in 1982, falling to 17.7 billion in 1989. Yet transit's share of urban traffic continues to decline.

Many policy analysts argue the inevitability of commuter rail decline, because they believe that commuter rail cannot operate effectively in any but the traditional suburb-to-CBD role (*2*). Suburban trip ends are too dispersed to be connected with single fixed-route rail lines in such a way as to create sufficient passenger densities to justify construction and operation of the lines. Indeed, similar arguments are applied even to the operation of bus lines in the suburbs (*10,12*).

Others counter by arguing that it is possible to supply the suburbs efficiently with rail and bus service. To do so requires planners to think in terms of networks of interconnecting routes that feed suburb-to-suburb as well as suburb-to-CBD passengers into each other. Such thinking stands in contrast to the usual concept of transit as collections of individual routes and their feeder, each serving CBD-bound trips from different suburban areas, but with little transferring of passengers between routes from each sector and no suburb-to-suburb riding in any sector. Networks of transit routes, if well conceived, have scope economies that accumulate passenger densities on each link, even in areas of thin demand. Scope economies account for the trends toward market concentration in the deregulated airline and trucking industries, even though the air and truck technologies do not possess scale economies (*13–15*).

Still others argue that even creating such route structures would not attract the suburb-to-suburb traveler. This is because transit is not as attractive as driving, so that those who have a choice will not choose transit unless there is a disincentive to drive. Driving disincentives, such as tolls or high parking charges, generally apply to the suburb-to-CBD or other CBD-related trips but not to suburb-to-suburb trips (*16,17*). Moreover, suburb-to-suburb travel generally involves transit disincentives in the form of site and street design that is hostile to pedestrians. This is because suburbs were built when the automobile was the dominant transportation mode. Poor pedestrian access reduces the likelihood of suburb-to-suburb transit travel even more (*4,18*).

The purpose of this research is to test the extent to which suburb-to-suburb commuter rail service is used where it is provided. Generally, such locations are few in number, because the planners of most commuter rail services, even the most recently inaugurated ones, conceived of them only in the traditional suburb-to-CBD role. They have not planned the lines to serve edge cities or to link together with other commuter lines or other types of transit service to form networks where extensive suburb-to-suburb travel opportunity is available to the traveler. Despite such oversight, almost all rail commuter lines inadvertently serve a small number of suburb-to-suburb markets. This is because they have trains that originate in the distant suburbs and then stop numerous times as they proceed into the CBD. The intermediate stops are intended to allow additional CBD-bound passengers to board, but they could be used by passengers wanting to go from one suburban station to another. The questions explored here are whether there is any demand between such stations, and to what extent the rail service taps whatever demand there is. If there is no demand, or if there is demand but rail service fails to penetrate it, there is no point in trying to reorganize existing commuter rail services or plan new ones to serve the suburb-to-suburb market. On the other hand, if there is demand that is penetrated, planners might be well advised to consider ways in which they can serve more such markets.

The focus of this experimental design is Southern California's Metrolink, a new commuter rail network recently established by the Southern California Regional Rail Authority (SCRRA). SCRRA purchased nearly 400 mi of tracks once owned by the Atchison, Topeka and Sante Fe Railway and the Southern Pacific Company. It subsequently entered into an agreement with the Union Pacific to use about 60 mi of additional line. It then had the lines rebuilt to accommodate peak-period commuter trains from suburban points on five lines to Los Angeles Union Station (Figure 1).

Metrolink provides a traditional suburb-to-CBD service. It is not designed to serve suburb-to-suburb markets (except in the case of the Riverside to Irvine line, which opened in November 1995 after this paper was written), and to emphasize speedy service for long-distance commuters to downtown Los Angeles, each of

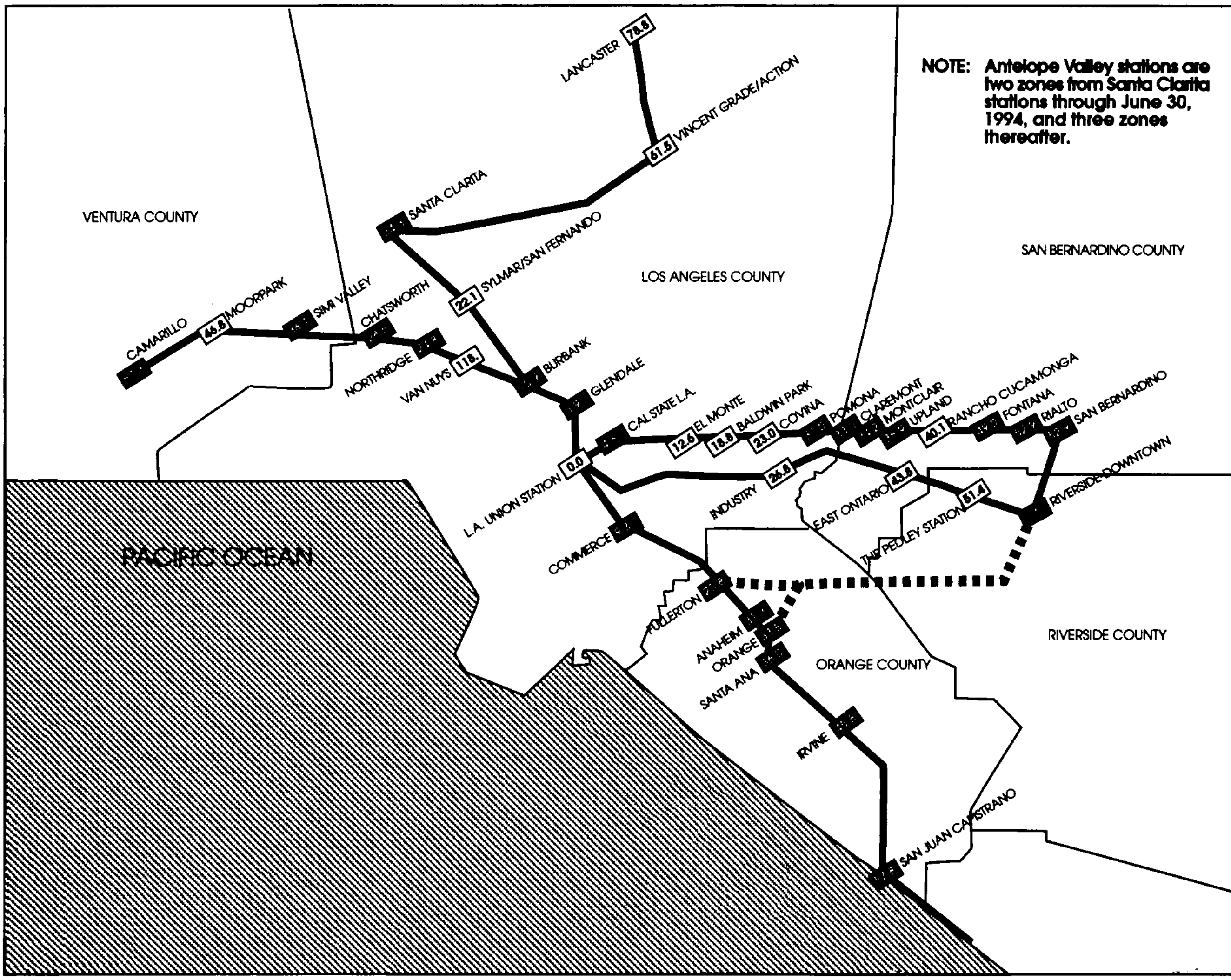

FIGURE 1 Metrolink mileage map—distance from Los Angeles Union Station. Riverside is 58.7 mi from Union Station via the Union Pacific line. Riverside via Fullerton is 68.8 mi. (Information provided by Metrolink.)

its lines has far fewer stations than is common for commuter operations. This makes the number of suburb-to-suburb station pairs that it inadvertently serves very few in number. Nevertheless, there are enough station-to-station pairs served to set up a quasi-experimental design to test the depth and penetration of suburb-to-suburb markets in comparison with suburb-to-CBD markets.

The two routes included in this study are those from Union Station to Riverside and Orange County. The original intent was to include the other three routes from Union Station, but complete origin-destination survey data were not available at that time. The additional data would have added to the strength of the study, because two of the routes included heavily used shuttle buses from two suburban stations to employment destinations within a 10-mi radius, inaugurated with Federal Emergency Management Agency funds in the wake of the January 1994 Northridge earthquake. A freeway competing with one of the two lines was closed for several months by the earthquake, but the freeway paralleling the other line remained open, enabling a test of how important shuttle bus service might be in attracting suburb-to-suburb riders. As it turned out, we could not obtain data for the two lines, so they were left out of the study.

Methodology

A quasi-experimental design was used to examine the size of various station-to-station markets and the degree to which Metrolink penetrated each of the markets. We used two categories of station type: suburb to suburb and suburb to CBD. For each type, we examined four distance categories: less than 11 mi, 11 to 20 mi, 21 to 30 mi, and greater than 30 mi. Two hypotheses were tested. One was that no significant difference existed in size or penetration of the two types of markets for a given distance category. The second was that as distance increased, market size decreased but market penetration increased for each type of station pair. The latter hypothesis reflects generally accepted distance-decay effects on the size of transit commuting markets (*19*), and it reflects the probability that commuter rail is not attractive for short-distance riding because of high initial fares and infrequent service. We did not control for other factors, such as fares or presence or absence of shuttle buses from suburban stations to nearby employment areas.

Two data sources, which we obtained with the assistance of Schiermeyer Associates, enabled us to estimate commuter market size for each station pair. Both were compiled by the Air Quality Management District (AQMD) in Southern California. One provides a listing of every company within the AQMD air shed area that has more than 50 employees. Each record for a company includes an identification code, address, ZIP code, and a count of the number of employees working in the company. The second AQMD data base records the number of employees residing in each ZIP code within the air basin. A worker listed in the second data base can be traced back to the first data base through a company identification code, making it possible to determine in which ZIP code areas an employee lives and works.

To measure the potential market size of each station pair, we drew 2-mi buffers around each station and then noted the ZIP codes that fell within each buffer. ZIP codes that had only a small portion extending into the 2-mi buffer were eliminated. ZIP code areas with a majority inside and only a portion outside the buffer were included. The decision to include or exclude ZIP codes lying both inside and outside the buffer zone depended largely on the size of the ZIP code area and the size of the portion lying within the buffer. Workers who both lived and worked in the ZIP codes so defined were considered potential rail commuters.

Two related criticisms have been made of this definition of potential. One is that the 2-mi radius is too conservative on the origin end of the trip. Most users gain access to the line by automobile, and whereas a majority of riders drive about 2 mi to board trains, some drive considerably further. This is particularly true at the suburban termini of the various Metrolink lines. The other criticism is that the buffer on the origin end of the trip should not be a fixed distance but should increase with trip length.

The criticisms have merit, but they affect our study design only in one area. We likely overestimate the distance-decay effect on the absolute size of markets, which is to say that we underestimate the size of potential markets, particularly for longer trips. In other areas the biases noted in the criticism are not severe, because our interest is in comparisons between market sizes and penetrations rather than in absolute sizes and penetrations. To the extent that we underestimate each station pair market by defining the origin-station buffer too restrictively, we do so equally for suburb-to-suburb and suburb-to-CBD categories of a given distance category.

The definition of potential has another bias toward underestimation of the size of the potential market. The bias results from including only workers in firms with 50 or more employees. This is unavoidable, given the only data source from which we could determine potential easily. It is likely, however, that a significant part of the work force is employed in firms with 49 or fewer employees, and their inclusion would increase the size of the potential rail rider pool. This point must be kept in mind when interpreting the results pertaining to potential. However, there is no reason to expect that this bias would act differently for suburb-to-suburb or suburb-to-CBD categories or for different distance categories.

Finally, the failure to consider nonworkers as potential rail riders also underestimates the size of potential rail demand. This again stems from the data source available to us. Whereas it could be a problem in analyzing some commuter rail operations, it was not a problem in analyzing Metrolink. Given that Metrolink was designed only with workers in downtown Los Angeles in mind and that at the time of the survey it did not offer much service other than weekday peak-period runs into Los Angeles in the morning and return trips in the evening, this bias likely did not affect results. It could affect analysis of a more fully developed commuter rail service that offered bidirectional midday, evening, and weekend services.

To examine market penetration of each station-to-station pair, we noted the actual number of passengers using Metrolink between each station pair and divided this by the potential riders, calling the resulting ratio the achieved potential ratio (APR). For example, if a station pair captures only 9 riders per day but its potential ridership is 483 riders per day, the APR is 0.018633. This shows that Metrolink is only capturing about 2 percent of the potential riders between the two stations in question.

The actual number of passengers came from an onboard passenger survey conducted by Metrolink in May 1994. Riders were asked to complete a questionnaire regarding their travel patterns and preferences of Metrolink services. The survey specifically had respondents note their origin and destination stations. Because the survey is a sample of the total ridership, the true ridership for Metrolink was greater than this study represents.

Because of the biases in estimating potential ridership noted earlier, the APRs could be greater than one. This posed no difficulty so long as APRs for station pair and

TABLE 1 Cross Classification of Demand Potential

Distance Category (miles)	Station-Pair Category					
	Suburb-CBD			Suburb-Suburb		
	Per Pair	# of Pairs	Total	Per Pair	# of Pairs	Total
0-10	574	2	1,148	659	22	14,498
11-20	0	0	0	70	10	700
21-30	50	4	200	19	14	266
31+	50	16	800	5	8	40
Average for All Distance Categories	97	22	2,134	287	54	15,498

distance classifications had similar biases. As discussed earlier, we believe they did.

The APRs thus calculated were then cross-classified by station pair type and by distance categories for hypothesis testing. We tested the effect of station pair type and distance on APRs. We also tested the effect of the interaction between station pair type and distance on APRs (*20*).

In cases where the potential ridership estimate is very small, even moderate amounts of reported patronage will result in extremely high APRs. For example, we estimated potential ridership for the station pair Industry to Union Station on the Riverside line as only 10 but the survey reports actual ridership of 278. This produces an APR of 27.8. Such a high APR is explained in this case by the fact that the Industry Station has very few residential areas within the 2-mi radius, so those persons using it are likely to be coming from outside that area and are not found in potential ridership capture.

This example is the most extreme in the study; however, there are other cases with very high APR values resulting from small estimates of potential ridership. Such outliers may skew the results. To ensure an accurate analysis, it is desirable to examine the data with the outliers, as well as to examine a data set that excludes extreme values. We analyzed the data both ways. In the data set without outliers all station pairs with a potential ridership lower than 25 persons are removed. This eliminated most of the extreme APR values, while maintaining most potential ridership and somewhat more than half of the station pairs.

Results

The results are presented in two parts. We first examine differences in potential ridership between each of the categories. We then examine differences in the degree to which Metrolink penetrates potential ridership in each category. In the examination of market penetration, we use both the original data sets and data sets with outliers removed.

Potential Ridership

The cross classification of potential ridership by station pair category and by distance is given in Table 1 for the original data set. Table 1 indicates potential for the average suburb-to-suburb station pair as about three times greater than that for suburb-to-CBD. In addition, there are more than twice as many suburb-suburb pairs as suburb-CBD pairs. Together, these two points explain why the suburb-suburb category has much more potential (15,498) than the suburb-CBD category (2,134).

The traffic potential in the two station-type categories is distributed very differently over the distance categories. Most of the suburb-to-suburb and almost none of the suburb-to-CBD potential is in the short-distance categories. This is accounted for by the large number of suburb-to-suburb (22) and the small number of suburb-to-CBD (2) observations in the distance category 0 to 10 mi. There are no suburb-to-CBD observations in the distance category 21 to 30 mi. The paucity of observations in the suburb-to-CBD shorter-distance categories reflects Metrolink's orientation to the longer-distance commute. The final system plan has few stations within 30 mi of the CBD, and some of those that are planned were not yet opened at the time of the survey.

In the distance category 21 to 30 mi, the potentials of the two station-type categories are about evenly matched, each having a potential in the range of 200 to 300 passengers. The average station pair in the suburb-to-suburb category has only about 40 percent of the po-

TABLE 2 Cross Classification of Demand Potential for Purged Data Set

Distance Category (miles)	Station-Pair Category					
	Suburb-CBD			Suburb-Suburb		
	Per Pair	# of Pairs	Total	Per Pair	# of Pairs	Total
0-10	574	2	1,148	659	22	1,430
11-20	0	0	0	112	6	672
21-30	95	2	190	46	4	184
31+	92	8	736	31	1	31
Average for All Distance Categories	173	12	2,076	466	33	15,378

TABLE 3 Cross Classification of APRs for Original Data Set

Distance Category (miles)	Station-Pair Category (mean value of APR in each category)		
	Suburb-CBD	Suburb-Suburb	Average over station types
0-10	.01 (2)	.07 (22)	.07 (24)
11-20	.00 (0)	.37 (10)	.04 (10)
21-30	7.80 (4)	2.22 (14)	3.46 (18)
31+	2.90 (16)	3.95 (8)	3.25 (24)
Average over all distances:	3.53 (22)	1.30 (54)	1.96 (76)

Note: Numbers in parentheses are number of observations in each category.

tential of the average suburb-to-CBD station, but there are 2.5 times as many suburb-to-suburb station pairs in this category.

In the category greater than 30 mi the suburb-to-CBD station type has the most potential at 794 passengers compared with 43 potential passengers in the suburb-to-suburb category. The average suburb-to-CBD station has about 10 times the potential of the average suburb-to-suburb station, and there are twice as many of them. The strength of the suburb-to-CBD station category in the longest distance classification again reflects Metrolink policy.

For both suburb-to-suburb and suburb-to-CBD categories Table 1 clearly shows a distance-decay effect. It is strongest for the suburb-to-suburb station category. As trips become longer, potential falls off. This effect is as expected, but because of the data biases already discussed, the effect probably is overstated, particularly for the suburb-to-CBD stations pairs.

The conclusions reached about the distribution of potential demand from Table 1 are strengthened by an examination of Table 2. The generalization can be made that for the suburb-to-suburb station category most demand is in the shorter distances. A very strong distance-decay effect is shown, which likely would remain after biases inherent in the data were corrected. On the other hand, for the suburb-to-CBD station category there is less of a distance-decay effect, which falls off completely in the two longest distance categories. If biases inherent in the data were corrected, this might be reversed.

Market Penetration

Two tables indicate market penetration. Table 3 gives the distribution of market penetration over station-type and distance categories for the original data set. Table 4 does the same for the purged data set, from which observations having fewer than 25 trips were removed. As discussed earlier, this was done to reduce volatility in the APR ratio, which can occur when the denominator (po-

TABLE 4 Cross Classification of APRs for Purged Data Set

Distance Category (miles)	Station-Pair Category (mean value of APR in each category)		
	Suburb-CBD	Suburb-Suburb	Average over Station Types
0-10	0.01 (2)	0.08 (22)	0.07 (24)
11-20	0.00 (0)	0.11 (6)	0.11 (6)
21-30	0.71 (2)	0.64 (4)	0.65 (5)
31+	3.07 (8)	1.13 (1)	2.85 (9)
Average over Distance Categories:	2.30 (12)	0.19 (33)	0.72 (44)

Note: numbers in parentheses are number of observations in each category.

TABLE 5 Summary of Computed *F* Statistics

	Original Data Set	Refined Data Set
Due Distance	32.61	74.88
Due Location	50.68	379.81
Distance/Location Interaction	30.7	210.76

Note: All values are significant at the one percent level.

tential trips) is small. Table 3 indicates negligible market penetration for the suburb-to-CBD category in the two shortest distance categories, but surprisingly large penetration in the longest two. The suburb-to-suburb category shows small penetration (0.07) in the shortest category, but given the large potential in this category (14,322 trips), more than 1,003 trips actually occur in it. As distance increases, the penetration of the suburb-to-suburb category also increases to surprisingly large levels, but potential declines.

Table 4 also strengthens the conclusion reached in Table 3 that as distances increase, so does market penetration. This trend is evident for both categories of station type, but it is particularly pronounced for the suburb-to-CBD category. The large APR for the longest distance category probably reflects users from distant locations making long drives to the terminal stations to access the trains. It is clear from these results that the pattern of potential and the degree to which it is tapped are different for suburb-to-suburb trips than for suburb-to-CBD trips. Both categories display distance-decay characteristics, but distance decay is stronger for suburb-to-suburb trips. Both categories indicate higher market penetration with distance, but the degree of market penetration increases more for suburb-to-CBD trips. These conclusions are confirmed in an analysis of variance in APRs, the measure of market penetration, as given in Table 5 for both data sets. Table 5 indicates that station-type category, distance category, and the interaction of the two categories all are highly significant in explaining market penetration. If one switches from a suburb-to-suburb station pair to a suburb-to-CBD pair for a given distance category, market penetration increases. If one switches from a shorter distance category to a longer distance category for a given station type, market penetration increases. The interaction effect confirms that market penetration rises more rapidly for the suburb-to-CBD category with increasing distance. These results cause us to reject the hypothesis that commuter rail can tap suburb-to-suburb markets to the same extent they can tap suburb-to-CBD markets. The results also cause us to accept the distance-decay hypothesis on market potential as well as the hypothesis that market penetration is easier with longer distance.

Having come to these conclusions, we still are impressed by the extent to which there is a latent suburb-to-suburb market for commuter rail even for a system whose planners did not lay out its routes and stations to serve it. We equally are impressed by the degree to which trains penetrate the suburb-to-suburb market. For stations less than 10 mi apart the latent market is in many instances large; what is surprising is that Metrolink with its peak-hour-only trains and high initial fares gets about 7 percent of it. It appears plausible that more frequent service and fares oriented to short-distance riders might get more passengers on board in the outer suburban areas where most of the seats are empty.

There also is significant potential from distant suburban points to large suburban employment centers, such as Fullerton, Santa Ana, and Commerce, with an average APR of 1.13 on suburb-to-suburb commutes greater than or equal to 31 mi. Metrolink taps about 60 percent of such potential. This observation suggests that planners should consider locating suburban stations not only to facilitate access to and from the homes of commuters but also to facilitate access to and from major employment centers in the suburbs. Doing so in conjunction with employer-provided shuttle vans or local transit could increase ridership significantly.

There obviously are implications for how the polycentric region could be served by commuter rail. One is that traditional CBDs probably should remain the focus of service into the foreseeable future. However, rail lines serving traditional CBDs also should attempt to serve major suburban employment centers near tracks. This would require stations as near as possible to the centers with train service coordinated with local transit or employer-provided shuttles.

Despite our inability to get data that would have allowed us to examine the emergency-funded shuttle buses on two other lines, we were able to examine survey questionnaires to get a sense of shuttle bus importance, which appears to be considerable. The Metrolink survey data provided a breakdown of the stations providing such services. We found that up to 30 percent of departing passengers at suburban stations used shuttle bus service. The largest percentages were at the Fullerton and Anaheim stations. This may be due to the proximity of these stations to major employers for that area. The California State University at Fullerton lies just at the 2-mi buffer for the Fullerton station and is a major employer in the area. Anaheim Station lies within 2 mi of Disneyland. Further expansion of shuttle bus service at suburban stations could increase the ridership traveling to those destinations.

In addition to having shuttle buses, regional trains and regional buses should be operated as networks to create large numbers of suburb-to-suburb station pairs, many of which have significant destinations associated with them. Even with the two Metrolink lines that we examined and their very sparse station spacing, the number of suburb-to-suburb station pairs is considerably larger than the number of suburb-to-CBD pairs. A lower market penetration of individual suburb-to-suburb station pairs could more than be made up for by planners systematically creating large numbers of them. This suggests that systems serving polycentric areas could acquire additional lines to those focused on the CBD to better serve suburb-to-suburb commuters.

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