Title

From elevated freeways to surface boulevards: neighborhood and housing price impacts in San Francisco

Authors

Cervero, Robert
Kang, Junhee
Shively, Kevin

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From Elevated Freeways to Surface Boulevards:
Neighborhood, Traffic, and Housing Price Impacts in San Francisco

Robert Cervero, Junhee Kang, and Kevin Shively
Department of City and Regional Planning
University of California, Berkeley

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ABSTRACT

Freeway “deconstruction” marks an abrupt shift in urban policy. Priorities are shifting away from designing cities to enhance mobility toward promoting economic and environmental sustainability, livability, and social equity. This paper investigates the neighborhood, traffic, and housing price impacts of replacing elevated freeways with surface boulevards in two notable yet different corridors of San Francisco: Embarcadero along the city’s eastern waterfront and Central Freeway/Octavia Boulevard serving a predominantly residential neighborhood west of downtown. A combination of informant interviews, literature reviews, and statistical analyses are used in examining neighborhood, traffic, and housing impacts of these two roadway conversions. The research shows freeway conversions generally lead to gentrification of once-declining neighborhoods, although public policies like affordable housing mandates can temper displacement effects. In general, operational and improvements to surface streets along with enhanced transit services and walking environments have accommodated considerable shares of former freeway traffic so as to avoid the traffic nightmares that were predicted when grade-separated freeways were removed. Empirical evidence on residential sales transactions reveals that the dis-amenity effects of proximity to a freeway have for the most part given way to amenity benefits once roadways are converted to nicely landscaped multi-way boulevards. We conclude that freeway-to-boulevard conversions, a form of urban re-prioritization that gives more emphasis to neighborhood quality and less to automobility, have yielded net positive benefits without seriously sacrificing transportation performance.

1. Introduction

A new relationship between elevated freeways and central-city neighborhoods seems to be forming. Despite worsening traffic congestion, a number of American cities have torn down or are in the midst of demolishing elevated structures in favor of at-grade boulevards and arterials with far less traffic carrying capacities. Nowhere has this been more evident than in San Francisco, thanks in part to the Loma Prieta earthquake of 1989. The damage caused by Loma Prieta forced city officials to address whether to sink funds into building new facilities and seismically retrofitting existing ones, or replacing structures with slower moving at-grade facilities while at the same time opening up access to waterfronts, removing physical obstructions, and revitalizing economically stagnant neighborhoods. In San Francisco’s case, demolition of the elevated Embarcadero Freeway, along with assorted streetscape enhancements and urban re-designs, has radically transformed the city’s downtown waterfront, creating an attractively landscaped, pedestrian-friendly corridor. Just west of downtown San Francisco, several miles of the Central Freeway spur were also torn down, replaced by the award-winning Octavia Boulevard, improved pedestrian and bikeway facilities, and popular urban park.

True to its tradition as a pioneer of progressive urban planning, officials in Portland, Oregon decided more than 30 years ago to bulldoze the Harbor Drive freeway and replace it with a 37-acre waterfront park. Milwaukee recently tore down its Park East Freeway, opting to use the vacated land for housing, shops, and offices. Hoping to reverse the flight of households and businesses from the central city, then-Mayor John Norquist spearheaded a community-based effort to transform 26 acres of prime urban real estate to a New Urbanism-type "new town/in town". A ground-level six-lane boulevard, McKinley Avenue, has been constructed, adorned with tree-lined medians, granite pavers, and wide sidewalks. Freeway "deconstruction" is planned for the Innerloop in Rochester, NY, Route 29 in Trenton, NJ, and the Whitehurst freeway in Washington, D.C. and serious discussions are presently under way to remove sections of the Jones Falls Expressway in Baltimore, Seattle's Alaska Way Viaduct, the Sheridan Expressway in the Bronx, the Robert Moses Parkway in Niagara Falls, and Interstate-5 in Portland.[1] The movement even has a global reach. Under the leadership of then-Mayor (and recently elected president of South Korea) Myung-Bak Lee, Seoul's Cheonggyecheon elevated expressway was torn down four years ago and the buried stream beneath it is brought back to the surface as a linear park and bike path. The mayor staked his 2002 mayoral election campaign on this $313 million project, calling it "a new paradigm for urban management in the new century" (Seoul Metropolitan Government, 2003). Echoing the sentiments of urban visionaries like Jaime Lerner of Curitiba, Brazil and Enrique Penalosa of Bogotá, Colombia, Mayor Lee's defense of the project is thus: "we want to make a city where people come first, not cars".

Freeway demolitions are a bold, and perhaps even risky, experiment in urban renewal. They also reflect a re-ordering of municipal priorities. Freeways stand as monuments to an era when high priority went to "mobility" – i.e., efficiency of automobile movements, in particular of professional-class suburbanites to good paying jobs downtown. Some were seemingly built without regard to the fact they severed longstanding neighborhoods, formed barriers and visual blight, cast shadows, and

[1] http://www.preservenet.com/freeways/index.html, web site on "Removing Freeways – Restoring Cities", Preservation Institute.

sprayed noise, fumes, and vibrations on surrounding areas. With the cumulative effects of designing the city for automobility evidenced by continued traffic jams, worsening environmental conditions, and dysfunctional urban districts, priorities are now shifting toward promoting economic and environmental sustainability, livability, and social equity. As Seoul's mayor said, the focus is on people and neighborhoods, not cars.

In keeping with smart-growth principles, freeway demolition can viewed as a "de-mobilization strategy"– redesigning the city to reduce car travel. In ways, freeway deconstruction is a corridor-scale version of neighborhood traffic calming, road "dieting", and more generally the automobile-liberating, pedestrian-friendly principles of New Urbanism. Critics charge that freeways induce car travel (e.g., "build it and they will come") and give rise to oppressive car-dependent landscapes, and reason that removing road capacity should have the opposite effect. As Milwaukee's former mayor John Norquist remarked: "The Park East Freeway creates congestion by encouraging people to travel further and further between increasingly insignificant places" (Schriebman, 2001, p. 10).

2. Research Focus and Approach

Advocates argue that bulldozing freeways will spur economic redevelopment by not only removing physical barriers and visual eyesores, but also by freeing up large swaths of valuable urban land for large-scale redevelopment projects. Critics counter, however, that central-city traffic congestion will worsen, and putting more cars and trucks onto surface streets will increase pedestrian fatalities. Some also fear that any economic gains will be offset by businesses leaving core cities in favor of freeway-served suburban locales.

Against this backdrop of controversy and uncertainty, this paper evaluates the impacts of removing elevated freeways and replacing them with surface-street boulevards on neighborhoods as reflected by changes in demographic and land-use compositions, traffic, and housing prices. Two corridors in San Francisco – Embarcadero and Central Freeway/Octavia Boulevard – are used as case contexts to explore these questions. The Embarcadero corridor lies on the eastern edge of downtown San Francisco, intersected by the city's main downtown artery, Market Street. The former Central Freeway traversed a first-tier ring outside of downtown San Francisco, serving a mixed-use corridor with a strong residential component (Hayes Valley). The two corridors, shown in Figure 1, lie just 2.3 miles from each other.

A mixed-methods approach was used in studying neighborhood and land-value impacts. Informant interviews and a literature review yielded background information and qualitative insights into neighborhood changes both in anticipation and the wake of freeway removal and boulevard replacement. Additionally, a matched-pair approach was employed to examine demographic and land-use attributes between 1990 (prior to) and both 2000 and 2005 (after) freeway removal based on block-level census statistics and land-use projection (available from the Association of Bay Area Governments). To examine impacts on property values, hedonic models were estimated using times series data on residential sales prices, housing and neighborhood attributes, and measures of proximity to transportation corridors (comprising freeways in some years and demolished projects and boulevard replacements in others).

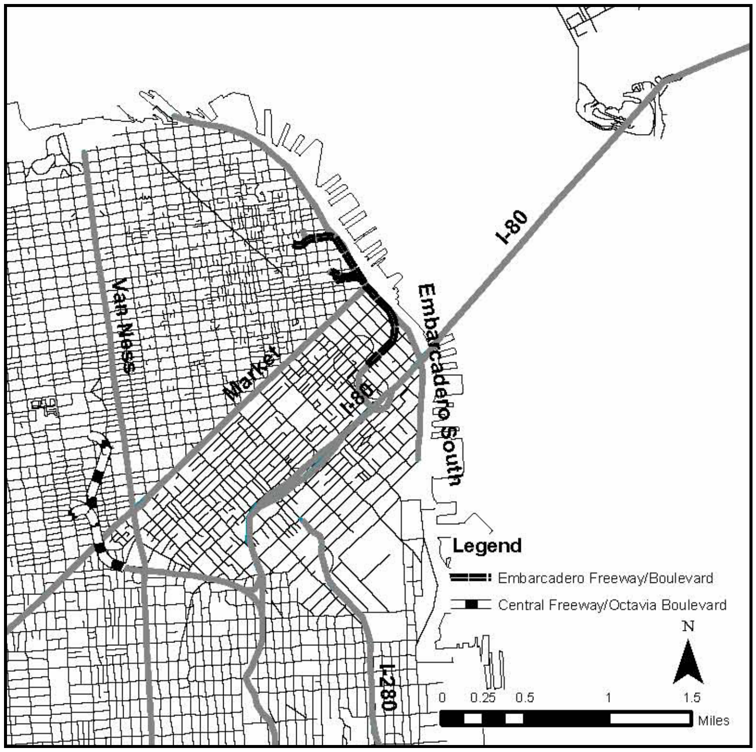


Figure 1. Two Case Study Corridors: Embarcadero Freeway/Boulevard and Central Freeway/Octavia Boulevard.

3. Project Backgrounds and Historical Perspectives

San Francisco activists were pioneers in the "freeway revolt" movement in the U.S. during the 1960s, halting the planned construction of two mammoth double-deckers: the fully extended Embarcadero Freeway, which was planned to traverse the city's northeastern waterfront connecting Golden Gate Bridge to the Bay Bridge, and the Central Freeway from Highway 101 (serving the peninsula to the south) to the Golden Gate Park along the Panhandle (Lathrop, 1971). Still, portions of these two elevated freeways were completed before the public backlash halted further expansion, providing grade-separated freeway connections in the city for nearly four decades (Figure 1). Before it was taken down, the section of the Embarcadero Freeway that was built connected the San Francisco Bay Bridge with Broadway Street, funneling motorists directly into the city's Chinatown and North Beach district. The Central Freeway spanned through the center of San Francisco, crossing over Market Street and connecting Highway 101 to the Fell-Oak one-way couplet that fed into Golden Gate Park and onwards to the Golden Gate Bridge. Both served as critical arteries in funneling motorists in and out of the city.

On October 17, 1989, the 7.1 magnitude Loma Prieta earthquake struck the San Francisco Bay Area, collapsing the upper deck of the Cypress Freeway across the Bay in Oakland, killing 42 people (Hastrup, 2006). Both the Embarcadero and Central Freeways were crippled but still standing. In the earthquake's aftermath, heated debates ensued over the future of the two double-decked freeways. The winds of change to remove elevated freeways from San Francisco were well underway before Loma Prieta. In 1970, 1980, and 1985, the San Francisco Board of Supervisors passed resolutions in favor of razing freeways, but these initiatives never mustered political support and financial backing at the regional or state levels.[2] One important precursor to freeway removal was the 1973 amendment to the Federal Highway Act which authorized withdrawal of unfinished segments of the Interstate highway system and their replacement with other transportation projects. This opened the way for federal financing of freeway teardowns as long as alternative travel means, including expanded surface streets and transit services, were available. Both the Embarcadero and Central Freeways were eventually

[2] Overseeing regional transportation projects was and remains the Metropolitan Transportation Commission (MTC), the nine-county region's regional transportation planning organization. At the state level, the California State Transportation Commission needed to approve freeway demolition.

torn down, though how decisions were reached and the road replacement strategies that followed differed quite a bit.

The Embarcadero Freeway Removal and Embarcadero Boulevard Replacement

Following Loma Prieta, California's state transportation agency, Caltrans, proposed three alternatives: (1) seismological retrofitting of the damaged structure, (2) rebuilding as a depressed freeway, or (3) demolishing and replacing with a grade-level street (SPUR 1990). Public opinions swayed back and forth on the issue, however over the course of extensive public debate it became increasingly evident that the majority of San Franciscans wanted the freeway permanently removed. In addition, it became increasingly evident that demolition and replacement was far more cost-effective than retrofitting the aging, damaged structure (Hastrup, 2006). Opportunities for revitalizing San Francisco's moribund eastside waterfront also weighed in the decision to demolish the freeway. Writes Rose (2003, p. 85): "Damage to the Embarcadero Freeway from the Loma Prieta quake revealed a landscape of striking views and singular opportunities for great public places along the waterfront – a gritty and largely hidden industrial zone to which the city had turned its back".

In March 1991, the demolition of the Embarcadero Freeway and its network of on- and off-ramps began and was completed by year's end. Freeway removal did not cause immediate traffic nightmares, as some had predicted. Much of the downtown traffic was rerouted to other Bay Bridge ramps and the freely flowing grid of surface streets south of Market Street. Improved signal timing, lane restriping, creation of oneway couplets, and expanded transit services further mitigated traffic impacts.

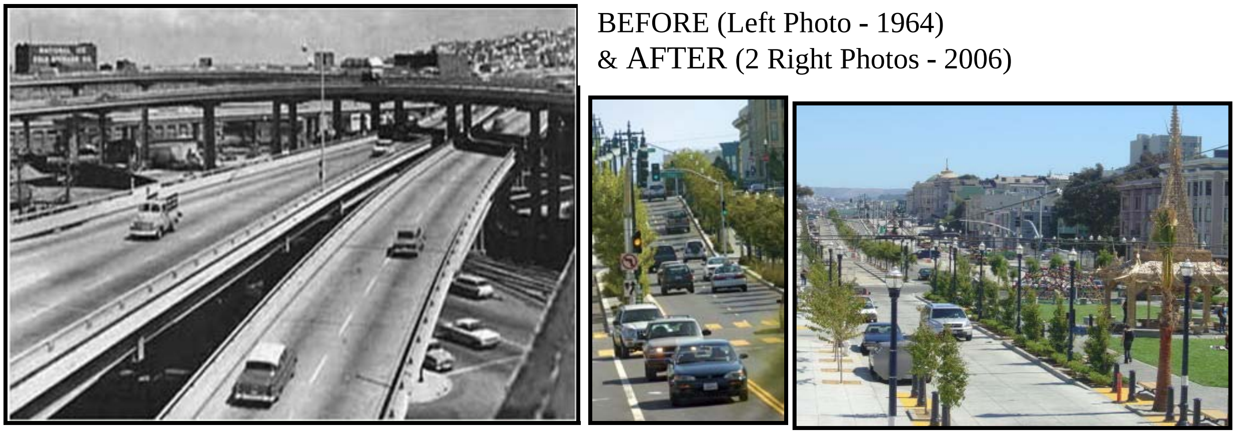
Embarcadero Boulevard took the demolished freeway's place and was completed in June 2000. Before and after pictures reveal the dramatic change to San Francisco's waterfront (Photo 1). The corridor formerly occupied by a double-decked freeway has been transformed into a multi-lane boulevard flanked by a promenade of wide sidewalks, ribbons of street lights, mature palm trees, historic streetcars, waterfront plazas, and the world's largest piece of public art (Rose, 2003; Fisher, 2005).

Photo 1. Transformation from the Embarcadero Freeway to the Embarcadero Boulevard. Photo credits: left three -- Roma Design Group; right -- San Francisco Cityscape.

The Central Freeway Removal and Octavia Boulevard Replacement

Removing the elevated Central Freeway and replacing it with a new surface street was a more drawn out, complicated process than with Embarcadero. The very northern section of the freeway (providing ramp connections to the Franklin and Gough one-way couplet) was so structurally weakened that it was demolished right after Loma Prieta. Six years later, in early-to-mid 1996, six blocks of the freeway's northern reach were also demolished because of structural deficiencies, in the words of one observer "leaving a glorified off-ramp stretching four clocks into the heart of the neighborhood and a serpentine path of vacant parcels" (Ducker, 2003, p. 86). What to do with the remaining portions of the Central Freeway became embroiled in controversy. A political vacuum slowed progress in part because the moderate-income Hayes Valley neighborhood bisected by the Central Freeway corridor was nowhere “as powerful a constituency as the downtown waterfront” (Hastrup, 2006, p. 68). Also, sharp disagreement among San Franciscans on the pros and cons of freeway removal prompted many local politicians to avoid the issue. Residents of nearby neighborhoods such as Hayes Valley and the Western Addition wanted the freeway torn down while those living elsewhere who regularly used the Central Freeway wanted to rebuild it. A citizen-initiated “ballot” battle ensued. In the late 1990s, a series of ballot measures and counter-measures on the freeway’s future failed to garner voter support (Hastrup, 2006; Macdonald, 2006).

Those in support of demolishing the freeway realized a respectable mobility option was needed given that the elevated structure carried 80,000+ vehicles per weekday (Billheimer, 1998). A multi-way boulevard, designed by the Cityworks team of Allan Jacobs and Elizabeth Macdonald, was a natural solution: a 133-foot-wide Parisian-style passageway with four central through-lanes flanked by two peripheral lanes for local traffic as well as parking (Macdonald, 2006). A central median and side strips would provide safe haven for pedestrians, an important consideration given some motorists would be former freeway users. Named Octavia Boulevard, this proposed surface-street alternative galvanized freeway-demolition supporters. A ballot measure to raze the remaining freeway segment and replace it with Octavia Boulevard was put before and approved by San Francisco’s electorate in late-1999. By August 2003 the Central Freeway was demolished to Mission Boulevard south of Market and a little over two years later, four blocks of the new Octavia Boulevard took its place. Photo 2 shows the before-and-after transformation.



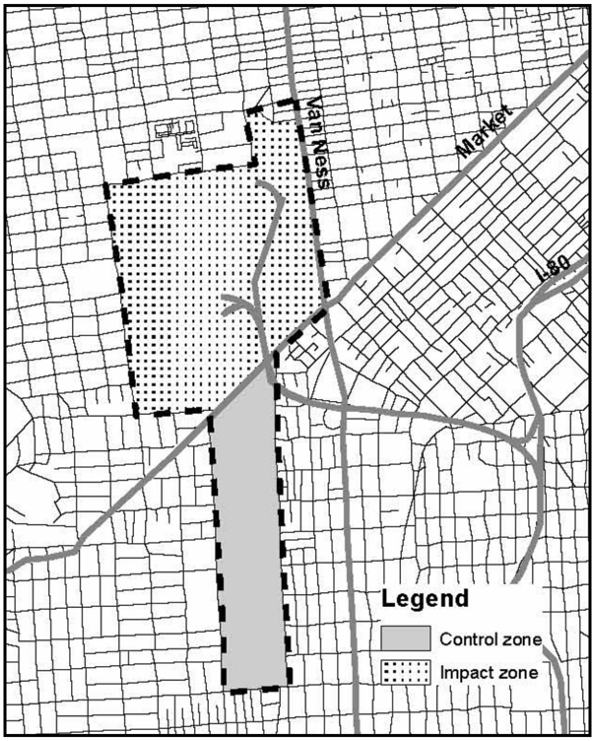
BEFORE (Left Photo - 1964)
& AFTER (2 Right Photos - 2006)

Photo 2. Transformation from Central Freeway to Octavia Boulevard. Photo credit: Left – California Highways and Public Works Department; Two Right – Noah Berger.

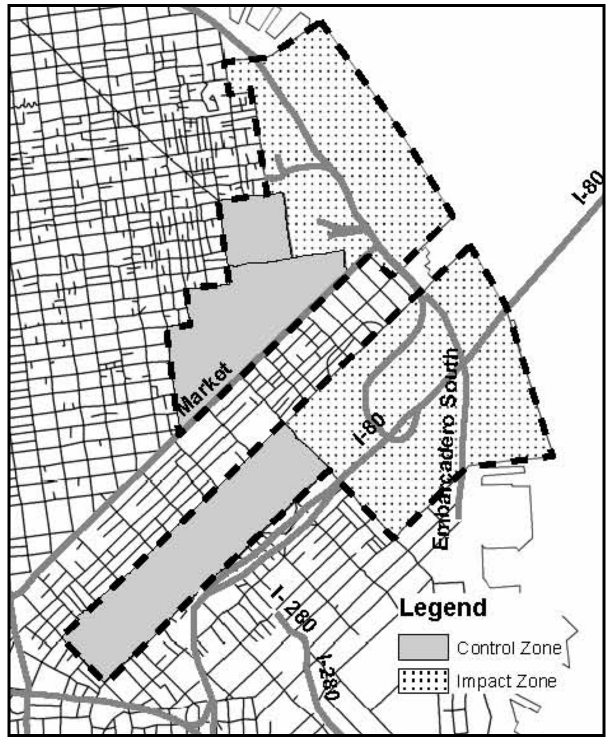
4. Neighborhood Impacts

To investigate the impacts of freeway-to-boulevard conversions on surrounding neighborhoods, a matched-pair comparison was initially turned to. The aim of matched-pair analysis is to compare experiences between two neighborhoods that are comparable except that one receives the "intervention" (i.e., freeway removal/boulevard replacement) and the other does not. In the course of conducting this research, it became apparent that there really were no suitable "control" neighborhoods – in terms of demographic and land-use make-up and similar geographic setting – from which to compare impacts. Nonetheless, in order to gain some insights into how neighborhoods changed before-and-after freeway removal, we opted for a "loose" matched-pair analysis, realizing the imperfect pairs ruled out any effort to draw strong inferences from the findings. Nevertheless, the neighborhood comparisons shed some light into how nearby neighborhoods – one directly bisected by the former freeway and the other not – changed during the 1990s and into the 2000s. These comparisons also aided in conducting informant interviews for they provided order-of-magnitude estimates of neighborhood changes from which knowledgeable individuals could react and offer possible explanations.

Figure 2 shows the locations of comparison neighborhoods for each study corridor. Comparison neighborhoods corresponded to census tracts. Finer-grained block-level data were also available however this more detailed resolution failed to provide any more insights into neighborhood changes than tract-level data. The left panel of Figure 2 shows the Hayes Valley tract that represents the "impact zone" (dotted pattern) for the Central Freeway/Octavia Boulevard corridor along with the comparison neighborhood south of Market Street along Guerrero Street (shaded pattern). This corridor's "comparison" neighborhood is more Latino in its household make-up and averages slightly lower incomes than the "impact" neighborhood. In the case of the Embarcadero corridor, shown in Figure 2's right panel, the "impact" neighborhood tract straddles the waterfront north and south of Market Street. Whereas the Central Freeway neighborhoods are predominantly residential in character, the Embarcadero corridor features a rich mix of office, commercial, institutional, and residential uses. Two inland mixed-use neighborhoods in eastern downtown San Francisco (including Chinatown) situated north and south of Market Street were chosen as comparison neighborhoods.



Central Freeway Case



Embarcadero Freeway Case

Figure 2. "Impact" and "Comparison" Neighborhoods for the Central Freeway and Embarcadero Freeway Cases

For data availability reasons, we relied upon tract-level statistics from the 1990 and 2000 censuses to compare changes between the "loosely" matched pairs of neighborhoods. Since most census data are for place of residence, the analyses presented in this section are mainly for residential uses. Tract-level place-of-employment data for 1990 and 2005 were available from ABAG, enabling longer term employment trends to be compared.

For the residential-level analyses, we compared "differences in differences" in the numbers and shares of households and individuals taking on various demographic, housing, and journey-to-work characteristics – i.e., 1990-2000 differences between the two neighborhoods. The two time points – 1990 and 2000 – were imperfect benchmarks to examine “impacts”. The 1990 time point marked the pre-demolition period for both study corridors (although both freeways were heavy damaged then). For the Embarcadero corridor, year 2000 corresponded to both post-demolition as well as the year that the replacement boulevard opened (specifically, in June 2000). Thus 1990-2000 census periods corresponds to an asymmetrical pre-/post-demolition comparison as well as a freeway/boulevard comparison – asymmetrical in the sense that demolition occurred in 1991, a year or so after the 1990 census. The comparisons for the Central Freeway corridor were even less tidy. Since only around two-thirds of the Central Freeway had been demolished and the Octavia Boulevard replacement was still five years away from opening, year-2000 corresponded to a “partial demolition” time point. Thus, the Central Freeway comparisons shed light into pre- and partial-post demolition impacts. In that the Octavia Boulevard replacement was approved by voters in 1999, some changes might have occurred in 2000 in anticipation of the improvement.

While “difference of difference” comparisons were made for dozens of indicators, only variables for which changes were notable are discussed in this section. Insights gained from informant interviews and a literature review are also woven into the discussions.

Embarcadero Freeway Corridor

During the 1990s, the “impact” zone along the former Embarcadero Freeway corridor generally fared better economically than the “comparison” neighborhoods some distance from the waterfront. Notably, from 1990 to 2000, there was a 54% increase in the number of housing units in the impact area versus a 31% increase in the comparison area. Moreover, employment trends varied. The number of jobs in the impact zone jumped 23% from 1990 to 2005 compared to a 5.5% rise in the comparison zone.[3] During this same period, employment in San Francisco's Chinatown, the northern terminus of the demolished freeway, fell by one-third.[4] Asian households were drawn to San Francisco's eastern waterfront, increasing by 185% during the decade of the 90s in the impact zone while declining in the comparison areas.

Statistics aside, most observers attribute the dramatic turnaround of downtown San Francisco's eastern waterfront to removing the freeway dis-amenity and replacing it by the boulevard/promenade amenity. This conversion, most agree, was a catalyst to a host of private investments that transformed San Francisco's waterfront over the past decade, including the renovation of Pier 1 (now offices) and the Ferry Building (a market hall and offices), and construction of the new Pacific Bell baseball park (Rose, 2003). Several blocks inland, once industrial areas south of Market quickly became thriving, high-density mixed-use neighborhoods. Farther away, the high-rise Transbay Terminal redevelopment and Rincon Hill redevelopment projects, hosts to high-density housing, likely enjoyed a halo effect from freeway deconstruction. Rose (2003, p. 873) contends: "The emergence of the South of Market (SoMa) area – and, in particular, the rise of "Multimedia Gulch" as the center of the dot.com revolution – also certainly was affected by the removal of the earthquake-damaged freeway ramps on nearby blocks".

While removing a freeway dis-amenity and replacing it with a boulevard/

[3] The strongest divergence was during the dot.com years of 1995 to 2000, when the number of rose by 43.4% in the impact zone versus 22.6% in the comparison area.

[4] While removing the Embarcadero freeway reduced car access to Chinatown among those coming from outside of San Francisco, most tourists who visit and shop in Chinatown do not drive, walking or taking public transit instead. San Francisco's Chinatown decline also occurred around the same time when other competing Chinese-American business districts (with better road access) were emerging in the Richmond District of San Francisco (along Clement Street) and in downtown Oakland.

promenade amenity no doubt influenced these transformations, so did the availability of land. Taking out ramps connecting the Embarcadero Freeway and Transbay Terminal to the San Francisco Bay Bridge freed up 650,000 square feet of prime real estate, enabling large-scale redevelopment projects to take root. Urban regeneration could have been due as much to the sudden availability of large tracts of well-located urban parcels as changes in roadway infrastructure.

There is some evidence that Embarcadero's freeway conversion has also promoted more sustainable transportation. Journey-to-work statistics for the 1990-2000 period show that public transit gained market share in the impact area, bucking trends citywide and contrasting with a declining share in the comparison areas. The replacement of a grade-separated freeway with a streetcar-served boulevard no doubt contributed to the 75% increase in transit commute trips recorded in the impact zone during the 1990s. Pedestrian amenities also seem to have induced some residents to walk to work. From 1990 to 2000, those walking to work rose by 1.6 percentage points in the impact zone compared to a 1.0 percentage point increase in comparison neighborhoods.

Central Freeway Corridor

The most notable demographic change that has occurred in the former Central Freeway corridor is gentrification. While all of San Francisco has gentrified to some degree over the past two decades, the entry of predominantly white, non-traditional households into the once freeway-severed Hayes Valley has been particularly pronounced. Areas within one to two blocks of the former elevated Central Freeway suffered from not only traffic noise and fumes but also blocked views, shadows, and people loitering underneath the freeway. Removing an eyesore and nuisance invariably triggered land-use and demographic changes.

Racial changes were especially notable during the 1990s, as the very diverse neighborhoods in the Central Freeway impact zone became increasingly white (11.5% increase in the share residents who are white). As whites moved into the neighborhood (32.9% increase in total white population), blacks moved out (35.9% decline). An opposing trend was evident in the comparison zone south of Market as the total population of whites and Asians fell by 3.9% and 22.6% respectively. Additionally, the 1990s saw the share of households with children fall more rapidly (37.0% versus 23.4%) in the impact than the comparison zone. While jobs growth occurred in both the impact and comparison areas, the Hayes Valley has witnessed an upsurge in higher end retail activities, prompting one observer to remark that the freeway-adjacent “Hayes Valley has become a haven for hip boutiques” (Rose, 2003, p. 87). Restaurants, bars, and entertainment venues that appeal to Richard Florida’s famously chronicled “creative class” have replaced mercantile type stores that that existed on Hayes Street prior to 1990 (Florida, 2002).

Local planners anticipated post-freeway gentrification. The Market-Octavia neighborhood plan calls for some 900 additional housing units to be built in the freeway corridor, some on parcels as narrow as 20 feet. Of all housing built on the “freeway parcel” (once owned by Caltrans and since transferred to the city), half is to be affordable to low and very-low income households. Also contributing to housing affordability has been the replacement of off-street parking minimums of 1.0 space per unit by maximums of 0.25 to 0.75 spaces per unit. The tuck-under, podium parking typically found in dense San Francisco can add between $35,000 and $50,000 cost to a residential unit, making it all the more difficult for moderate-income households to move into the neighborhood. Relaxing conventional parking standards expands housing choices, appealing to those who, for lifestyle reasons, prefer to live car-free or in an environment well-served by public transit. Car-sharing is likely also to find a ready-made market of customers in former freeway corridors with below-code parking standards.

5. Impacts on Residential Property Values

Real estate prices absorb the effects of public works projects, be they freeway demolitions, boulevard replacements, or pedestrian enhancements. To shed light on the net benefits or losses associated with freeway removal and boulevard replacements, hedonic price models were estimated. These regression-based models treat housing as a bundle of goods, assigning hedonic prices to each component that gives rise to value, such as size of parcels and improvements, quality of construction, neighborhood characteristics, and transportation infrastructure (Rosen, 1974).

Hedonic models allowed for the influences of the many factors that influence housing prices to be statistically controlled so the influences of proximity to the former freeway and new boulevard opening could be isolated. Dummy variables, like whether a property was situated within a quarter-mile of the freeway (or replacement boulevard), statistically captured the effects of accessibility (or the lack thereof) and amenity (or the lack thereof). Some of the predictor variables related to location, such as proximity to MUNI transit services, were measured using Geographic Information System (GIS) tools. Variables on neighborhood land-use characteristics (e.g., mixed-use and jobs-housing balance indices) were measured using 1990, 1995, 2000, and 2005 data obtained from the Association of Bay Area Governments (ABAG).

Property sales data came from Metroscan, a proprietary database on property sales transaction (obtained from county assessor records) for the San Francisco Bay Area, available from First American Real Estate Solutions, Inc. All sales price data were adjusted to 2007 currency based on San Francisco's housing price index. Sales transaction data were obtained for a 2-mile "impact radius" of the studied roadway corridors. For the Embarcadero corridor, 9,573 sale transactions were available for the 1986 to 2005 period, apportioned among housing types as follows: Condominium (85.7%); Apartment (6.2%); Duplex (6.1%); Mixed Use (1.3%, including Office & Residential, Office Condo, and Store & Residential); and Townhouse (0.8%). For the Central Freeway corridor, 10,237 parcel records were obtained for the period of 1987 to 2007, broken down as: Condominium (86.4%); Duplex (5.9%); Apartment (5.8%); Mixed Use (1.2%, including Office & Residential, Office Condo and Store & Residential); and Townhouse (0.8%).

Models were estimated using Ordinary Least Squares (OLS) techniques. Variables were included in models if they were consistent with hedonic price theory and offered reasonably good statistical fits. All variables in predictive models were statistically significant at the 5% probability level.

Embarcadero Corridor

The hedonic price model estimated for parcels within ** 2 miles of the Embarcadero corridor for the 1986 to 2005 period is presented in Table 1. Controlling for the influences of building and neighborhood characteristics, the following was found regarding the impacts of changing roadway infrastructure:

- Prior to demolition, a typical residential unit sold for $118,000 less (controlling for housing price inflation), suggesting the presence of a *dis-amenity effect* associated with being near an elevated freeway for some properties;
- Residential units generally fell in value by $64 for every foot from the Embarcadero corridor, suggesting an *amenity effect* associated with being close to the waterfront;
- Following the June 2000 boulevard opening, residential values typically fell by $300,000 in the impact zone, possibly reflecting the downturn in real housing prices in the post-dot.com era in downtown San Francisco (i.e., a possible confounding effect);
- The post-boulevard residential property decline within the 2-mile radius of the corridor was less for residential properties farthest from the corridor (most likely due to some kind of confounding influence);
- Proximity within a more immediate ¾ mile buffer of the Embarcadero corridor reduced values by $213,000 during the full time series, indicating a *nuisance effect* of residences being within an “ear shot” of busy motorways (both the freeway and boulevard); and
- An off-setting *amenity benefit* for residences within ¾ miles of Embarcadero Boulevard in the post-2000 period.

The influence of residential location in the Embarcadero corridor on housing prices clearly presents a complex set of relationships. The benefits and dis-benefits of residences being near a busy motorway adjacent to an expansive waterfront supplement and offset each other. The presence of statistically significant interactive terms in Table 1 underscores the complex nature of relationships. Using averages values for the building and neighborhood characteristic variables in the model, Figure 3 summarizes the net impacts of proximity to the roadway corridor for a "typical" residence.[5] Housing values generally fell with distance from the roadway corridor and adjusting for housing price inflation, prices tended to be highest after the June 2000 opening of the Embarcadero Boulevard. In relative terms, the biggest differential in inflation-adjusted housing prices before and after the boulevard opening was between one-half and one-mile of the facility. Overall, experiences over the past two decades along the Embarcadero corridor suggest proximity to the waterfront produces high residential values and the boulevard slighted enhanced this, with all properties within a two-mile radius enjoying benefits.

Other predictor variables in Table 1 generally match expectations. A home's size, age, and bathroom count adds values. So does neighborhood density. Mixed-use milieus in a downtown setting, however, detracted from residential sales prices.

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[5] Mean values were used for ratio-scale predictor variables (e.g., Structure Age and residential density) and modal values were used for nominal variables (e.g., structure materials).

Table 1. Hedonic Price Model for Predicting Residential Property Values near Embarcadero Corridor in San Francisco, 1986 to 2005; Dependent Variable = Price ($) per sold residential units, in 2007 currency

Variable	B	Std. Error	t	Sig.
Building Characteristics				
Structure Size (Square feet)	174.8	2.7	65.9	0.00
Bathrooms (Number)	1,977.4	719.0	2.8	0.01
Structure Age (Years)	1,349.7	243.5	5.5	0.00
Structure Material (Masonry=1; otherwise=0)	-108,092.7	33,522.6	-3.2	0.00
Neighborhood Characteristics				
Residential Density (Number of Households per gross acre)	2,356.9	720.9	3.3	0.00
Employment Density (Number of Employees per gross acre)	605.3	112.4	5.4	0.00
Mixed-Use Entropy Index*	-570,543.4	70,435.7	-8.1	0.00
Roadway Infrastructure Characteristics				
Freeway Pre-demolition Period (January 1986-February 1991=1;otherwise=0)	-118,263.4	26,216.4	-4.5	0.00
Distance Effect: straight-line distance, in feet, from freeway/boulevard centerline to property	-64.1	3.8	-16.8	0.00
Boulevard Opening (June 2000-2005=1; otherwise=0)	-300,757.1	57,893.3	-5.2	0.00
Interaction: Distance Effect * Boulevard Opening Effect	34.3	5.5	6.2	0.00
Proximity Effect: Property is located within 0.75 mile of freeway/boulevard =1; otherwise=0)	-213,621.3	42,795.6	-5.0	0.00
Interaction: Proximity Effect * Boulevard Opening Effect	283,740.0	59,255.2	4.8	0.00
Constant	1,649,995.3	83,027.8	19.9	0.00

* Mixed-Use Entropy = $\{ - \Sigma_k [(p_i) (\ln p_i)]\}/(\ln k)$, where: p_i = proportion of total land-use activities in category i (where the i categories are households, retail employment, office employment, other employment); and k = 4 (number of land-use categories).

Summary Statistics:
N = 7,278
F statistics (probability) = 449.221 (0.000)
R^2 = 0.446

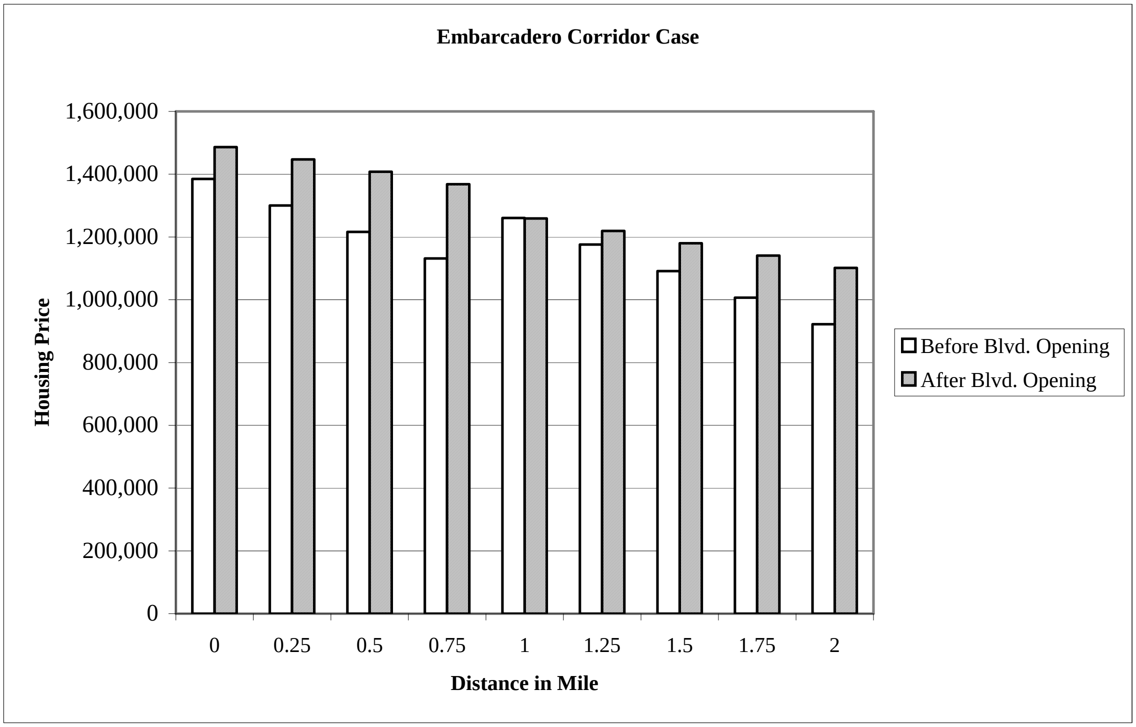


Figure 3. Estimated Residential Sales Prices (2007 $) as a Function of Distance from the Embarcadero Corridor for "Typical" Property, 1986 to 2005

Central Freeway/Octavia Boulevard Corridor

Table 2 presents the hedonic price results for the Central Freeway/Octavia Boulevard corridor over the 1987 to 2007 period. Controlling for property and neighborhood attributes, the model results reveal that residential sales prices for parcels within 2 miles of the corridor:

- Increased with distance from corridor, likely reflecting a *dis-amenity effect* of proximity to a busy roadway (mainly the elevated freeway);
- Jumped by $116,000 in 2005, the year the Octavia Boulevard opened, likely reflecting an *amenity effect* in anticipation of the benefits conferred by the boulevard; and

- The boulevard's *amenity effect* tapered with distance from the corridor.

As with the Embarcadero corridor, the relationship between housing prices and proximity to the roadway corridor does not follow a simple pattern. In general, prices increased with distance from the corridor, reflecting mainly the dis-amenity impact during the years the elevated freeway was in operation. In 2005, this dis-amenity effect was moderated by the opening of Octavia Boulevard. The plot in Figure 2, produced for the "typical" residence in the database, summarizes the key hedonic price results: housing values generally rise with distance from the corridor, however this impact was moderated by the opening of Octavia Boulevard. Indeed, the biggest before-and-after differential was for residences within ¼ mile of the boulevard.

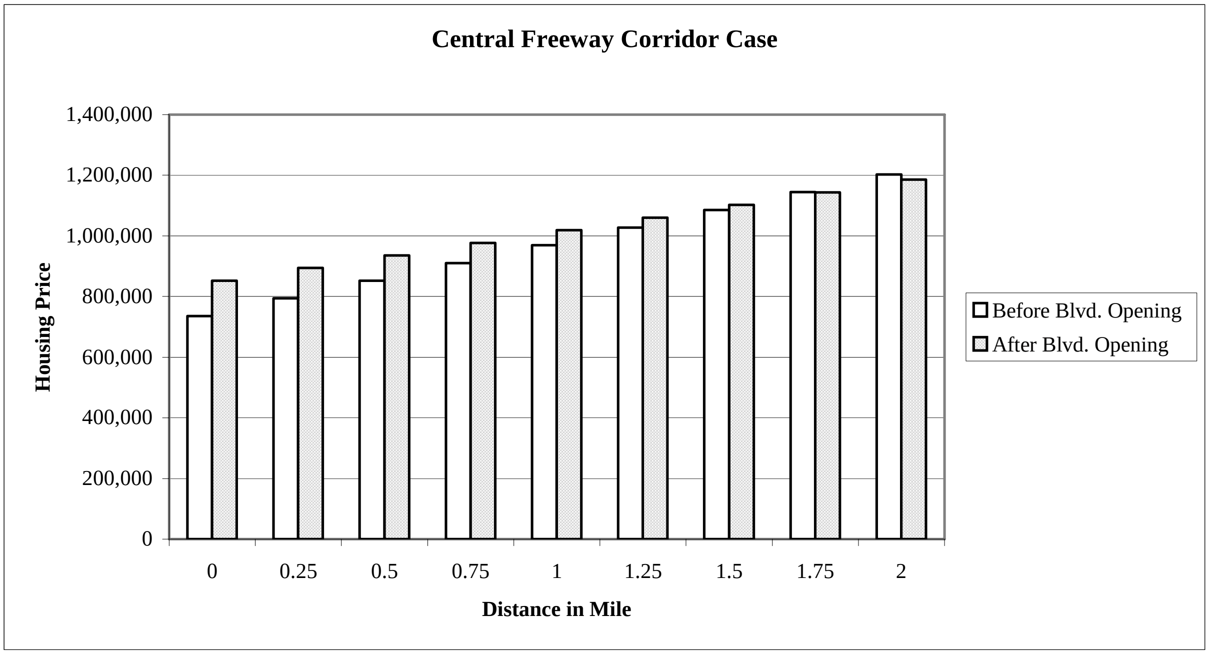
Other variables in the hedonic price models match expectations. Proximity to a Muni station increased home prices, particularly for large residences. Mixed-use development, reflected by the jobs-housing balance index, also appeared to increase residential values.

Table 2. Hedonic Price Model for Predicting Residential Property Values near Central Freeway/Octavia Boulevard Corridor in San Francisco, 1987 to 2007; Dependent Variable = Price ($) per sold residential units, in 2007 currency

Variable	B	Std. Error	t	Sig.
Property Characteristics				
Structure Size (Square feet)	173.2	2.8	61.2	0.00
Bathrooms (Number)	1,695.2	692.6	2.4	0.01
Structure Age (Years)	1,381.2	199.5	6.9	0.00
Neighborhood Characteristics				
Transit Accessibility: Within 1/4 mile of MUNI railway station (1=yes; 0=no)	63,525.0	17,054.4	3.7	0.00
Interaction: Transit Accessibility * Structure Size	33.1	4.6	7.2	0.00
Employment Density (Number of Employees per gross acre)	702.0	94.9	7.4	0.00
Jobs and Housing Balance Index*	197,451.7	30,944.8	6.4	0.00
Freeway Deconstruction Characteristics				
Distance Effect: straight-line distance, in feet, from the freeway/boulevard corridor to property	44.2	2.7	16.5	0.00
Boulevard Opening Effect (1= 2005; 0=otherwise)	116,603.1	30,301.9	3.8	0.00
Distance Effect * Boulevard Opening Effect	-12.7	3.2	-3.9	0.00
Constant	216,511.2	29,822.5	7.3	0.00

- Jobs-Housing Balance Index = (1-abs[Employed Residents – Total Employees / Employed Residents – Total Employees])

Summary Statistics:
N = 9,772
F statistics (probability) = 789.228(0.000)
R^2 = 0.447



6. Traffic and Safety Impacts.

In the near term, the removal of freeways unquestionably reduces roadway capacity. Unless surface-streets are redesigned, signalization systems and transit services are upgraded, alternative routes are created, and some former motorists opt not to travel, traffic congestion will increase. Some fear that pedestrian accidents and casualties will also rise – transferring fast-moving traffic from grade-separated structures to surface streets dramatically drastically increases potential conflicts between cars and pedestrians. Are such fears warranted?

In a study of over 100 cases of road-capacity reductions (e.g., street and bridge closures, car-free zones, roadway demolitions) in Europe, North America, Japan, and Australia, Goodwin et al. (1998) found an average overall reduction in motorized traffic of 25 percent, even after controlling for possible increased travel on parallel routes. This “evaporated” traffic was assumed to represent a combination of people forsaking low value-added (discretionary) trips and opting for alternative modes, including transit riding, walking, and cycling. Over time, the researchers note, traffic declines appear to be offset by latent demand and secular increases in travel.

Many transportation officials and business leaders opposed removal of the Embarcadero and Central Freeways on the very grounds that traffic congestion and car-pedestrian accident levels would increase. One year after the 1989 Loma Prieta earthquake, annual vehicular injury accidents increased by 24% from pre-quake levels; post-quake pedestrian-related accidents, however, fell by 3% (SPUR, 1990). By the late 1990s, San Francisco had the highest rate of pedestrian injuries and fatalities of any California city (Surface Transportation Policy Project, 2000). Some contended this was a consequence of freeway removal – notably, intermixing formerly grade-separated traffic with pedestrians. To accommodate increased traffic, city engineers introduced a dynamic signalization system that allowed “green waves” of traffic that formerly moved on elevated freeways to move swiftly along city streets used also by pedestrians and cyclists. Fast-moving surface-street traffic is a cardinal sin the minds of many New Urbanists.

There was a lot of hyperbole about the traffic nightmares that would be caused by freeway removal. When Caltrans closed the middle section of the Central Freeway in 1996, the director of operations predicted there would be bumper-to-bumper traffic for 45 miles east across the Bay Bridge and south into the San Francisco peninsula. State traffic planners warned that morning commutes would increase by as much as two hours. Fortunately, these nightmarish scenarios never materialized, though traffic congestion continues to worsen in San Francisco, as it has in all U.S. cities with growing economies (Texas Transportation Institute, 2007).

In examining traffic impacts, it is helpful to understand what happened to the 80,000 cars per day that formerly used the Central Freeway. How many were absorbed by surface streets? Did some motorists switch to carpooling, bicycling, walking, or telecommuting? Did some stop making discretionary trips altogether? An evaluation of the closure of San Francisco's Central Freeway sought to assess the redistributive impacts on traffic and to evaluate the impacts of the "3 Es" of traffic mitigation strategies: engineering, education, and enforcement. When the freeway was closed in August 1996, so much media attention had been given to the possibility of traffic gridlock that the traveling public was evidently "scared away" from driving along the corridor (a repeat of the 1984 Los Angeles Olympics phenomenon wherein prior public announcements about the prospects of traffic gridlock prompted many residents to go on vacation or forego travel). A September headline of the *San Francisco Chronicle* proclaimed: "Traffic Planners Baffled by Success: No Central Freeway, No Gridlock, and No Explanation".[6] One analysis showed much of the former freeway traffic was redistributed: six weeks after the closure, 42% of the traffic that the closed portion of the freeway had carried was found on three primary detour routes; other routes outside of the primary detour routes recorded traffic increases that amounted to over half of the former Central Freeway volumes (Robbins et al., 2001). A survey mailed to 8,000 drivers whose license plates had been recorded on the freeway prior to the closure revealed that 66% had shifted to another freeway, 11% used city streets for their entire trips, 2.2% switched to public

[6] *San Francisco Chronicle*, September 13, 1996, p. B-1.

transit, and 2.8% said they no longer made the trip previously made on the freeway (Figure 4) (Systan, 1997). The survey also found that 19.8% of survey respondents stated they made fewer trips since the freeway closure. Most were discretionary trips, such as for recreation. Also, average one-way trip length increased by 7.7% (from 21.2 miles to 22.8 miles).

Some six months after the September 2005 opening of Octavia Boulevard, the former 93,100 vehicles recorded on the Central Freeway in 1995 had dropped by 52%, or to 44,900 vehicles. Today, Octavia Boulevard and the network of streets that link to it, operate at capacity during peak hours. As a result, some motorists have opted to continue using street detours that were planned more than a decade ago for the first Central Freeway demolition (San Francisco Department of Park and Traffic, 2006).

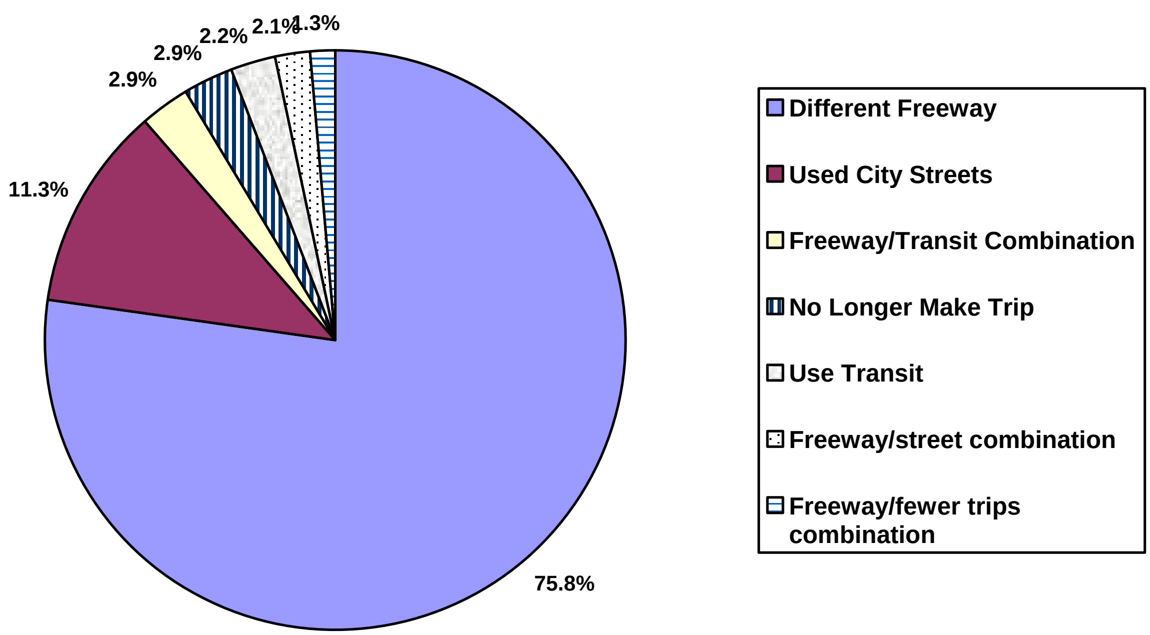


Figure 4. Source of Traffic Shifts Following Removal of San Francisco's Central Freeway

The traffic-carrying talents of well-designed boulevards might also explain the absence of traffic bedlam along the former Central Freeway corridor. A multiway boulevard is capable of handling large volumes of relatively fast-moving through-traffic (upwards of 6,000 cars per direction per hour) as well as slower local traffic within the same right-of-way but on separate yet closely connected roadways (Macdonald, 2006). It must be kept in mind, however, that the aim of boulevards is not necessarily to accommodate displaced or redistributed traffic. To do so would be to embrace road design practices of much of the post-second-war-world era. Writes urban designer Elizabeth Macdonald (2006, p. 6) about the possible traffic impacts of boulevards that replace freeways: "Focusing on every potential traffic conflict or possible bad-driver behavior and trying to solve each by adding greater lane widths, wider turn radii, great tree setbacks, or more movement restrictions is a misapprehension of the complex manner in which good boulevards operate".

7. Conclusion

At its core, the deconstruction of freeways represents a trade-off between mobility objectives on the one hand and urban re-generation and economic development objectives on the other. Experiences from San Francisco reveal that the replacement of elevated freeways with well-design surface boulevards can stimulate economic activities without necessarily causing traffic havoc.

Along both the Embarcadero and former Central Freeway corridors, the replacement of freeways with boulevards has spurred reinvestment and some degree of gentrification. San Francisco planners have moderated potential displacement effects through affordable housing mandates and relaxing off-street parking requirements to economize on the cost of new housing construction. Empirical evidence on residential sales transactions reveals that the dis-amenity effects of proximity to a freeway have for the most part given way to amenity benefits once roadways are converted to nicely landscaped multi-way boulevards. In addition, a decade-plus since the Embarcadero Freeway and major segments of the Central Freeway were torn down, traffic snarls are no worse than in other corridors of the city, due to most traffic finding alternative routes, switching modes, or changing their travel behavior. We conclude that freeway-to-boulevard conversions, a form of urban re-prioritization that gives more emphasis to neighborhood quality and less to automobility, have yielded net positive benefits without seriously sacrificing transportation performance.

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