Post Office Box 76
Camp Sherman, Oregon 97730
15 May 2013

MTC
Plan Bay Area Public Comment
101 Eighth Street
Oakland, California 94607

Dear People:

Please consider the attached comments in response to Plan Bay Area and the Plan Bay Area draft environmental impact report. I am submitting these comments as an expert on land-use planning issues, having done research on land-use planning for nearly 40 years.

Among other things, I have written four books on land-use and/or transportation issues along with numerous papers on these subjects. I am attaching four of these papers to my comments:

- "The Planning Tax": An analysis of the effects of growth-management planning on housing affordability;
- "How Urban Planners Caused the Housing Bubble": An analysis of the effects of growth-management planning on home price volatility;
- "Does Rail Transit Save Energy or Reduce Greenhouse Gas Emissions?"
- "The Myth of the Compact City: Why Compact Development Is Not the Way to Reduce Carbon Dioxide Emissions."

I am also attaching to my comments papers by UC Irvine economist David Brownstone; UC Berkeley engineers Mikhail Chester and Arpad Horvath; and San Jose State University economists Tom Means, Edward Stringham, and Edward Lopez.

Sincerely,

Randal O'Toole
Senior Fellow
Cato Institute

# Comments on Plan Bay Area by Randal O'Toole, Cato Institute

## Executive Summary

Implementation of Plan Bay Area will require the demolition of more than 169,000 single-family detached homes, or one out of every nine such homes in the region, according to table 2.3-2 of the draft environmental impact report. Any earthquake or other natural event that resulted in this much destruction would be counted as the greatest natural catastrophe in American history.

Planners say this reflects a change in demand and in 2040 only 39 percent of Bay Area households will want to live in single-family detached homes. In fact, most Americans, now and in the future, do and will prefer single-family homes. For Plan Bay Area to work without expanding the region's "urban footprint," these 169,000 homes must be replaced by 870,000 townhouses and multi-family dwellings. Though the plan admits that only about a fifth of the region's land has been developed, planners did not even consider the option of making housing more affordable by developing more land.

Instead, planners' goal is to reduce greenhouse gas emissions by concentrating new housing along transit corridors and boosting rail transit service by more than 35 percent. This, they predict, will increase per capita transit ridership by 50 percent and reduce per capita driving by 6 percent. These predictions are highly optimistic considering that previous densification of the region and expansion of rail transit resulted in a 36 percent decline in per capita transit ridership and a 30 percent increase in per capita driving since 1982.

Even if planners' optimistic projections prove correct, data in the plan reveals that the twin policies of densification and rail transit will do little to meet state mandates to reduce greenhouse gas emissions and provide more affordable housing. A careful analysis of data in the draft environmental impact report reveals that these policies will reduce greenhouse gas emissions by less than 1 percent. Moreover, the plan itself admits that it will make housing less, not more, affordable.

These failings are the result of a shoddy planning process in which the prescriptions were determined in advance of any analysis of whether they would be either effective or cost-effective at meeting the plan's goals. Although planners developed five alternatives, all of them contained some version of these same prescriptions, giving readers and decision makers little choice but to accept those prescriptions.

The two most important prescriptions predetermined for the plan were to *target selected neighborhoods for densification* and *expand the capacity of the region's rail transit system*. Every alternative except No Project targets selected neighborhoods for densification, and even No Project would densify the region without targeting specific neighborhoods. Every alternative except No Project increases rail transit capacities by more than 35 percent, which is more than any alternative would increase bus or highway capacities, and even No Project increases rail capacities by 20 percent.

When the prescriptions in a plan are determined in advance, without regard to their cost-effectiveness, trade-offs, or the personal preferences of current and future residents of the region, the result is not planning but tyranny. To avoid this tyranny, Plan Bay Area should be scrapped and the entire planning process replaced by one that devolves planning decisions to as a local a level as possible.

# Four Decades of Failed Plans

After World War II, the San Francisco Bay Area was one of the fastest-growing regions in the country. Between 1950 and 1970, the combined San Francisco-Oakland-San Jose urbanized areas grew twice as fast as the average large U.S. urban area (those with more than a million people in 1950), and faster than every other such urban area except Los Angeles and Washington, DC. The San Jose urbanized area alone was by far the nation's fastest-growing urbanized area, as its population nearly hextupled in two decades.

This rapid growth led to alarms in the 1960s about the costs of sprawl. Due to these concerns, most of the cities and counties in the Bay Area adopted urban-growth boundaries in the early 1970s. Outside the boundaries, development was heavily restricted; inside the boundaries, many cities passed zoning ordinances that limited increases in density.

These combined restrictions led to a rapid rise in the cost of developable land and housing. As of 1969, Bay Area housing was still very affordable, with median housing prices in the San Francisco-Oakland urban area less than 2.3 times median family incomes and in the San Jose urban area less than 2.2 times incomes. When a home is twice someone's income, they can dedicate 25 percent of their income to a mortgage and pay it off in less than 15 years.[1]

With the adoption of growth boundaries and other land-use restrictions, by 1979, median home prices in San Francisco-Oakland and San Jose were both more than 4.0 times median family incomes. Someone buying a home that costs four times their income would have to dedicate considerably more than 25 percent of their income to a mortgage to pay it off in 30 years.

By 1989, Bay Area price-to-income ratios were 5.4 in San Jose and 6.7 in San Francisco-Oakland; by 2006, they were 8.9 to 10.9. Even with the recent fall in median housing prices, they were still 6.3 to 7.1 times median family incomes in 2011. If someone buying a home that costs six or more times their income dedicated half their income to a mortgage at a 2.5 percent interest rate, they still would not be able to pay it off in 30 years.

It is doubtful that many who supported the urban-growth boundaries when they were first drawn in the 1970s intended or expected median housing prices to rise to 6 to 11 times median family incomes. This was an unintended consequence of the plans. Since residents who already owned their own homes benefitted from this rise in prices, there was little political pressure to fix the problem.

Land-use regulation not only made housing unaffordable, it made housing prices far more volatile. While housing prices in unregulated areas closely mirror median incomes, the above numbers show that Bay Area prices swing wildly, and the region has suffered at least three housing bubbles—one in the late 1970s, one in the late 1980s, and one in the mid-2000s—since imposing growth boundaries.

One reason for volatility is the lengthy permitting process imposed by cities that know developers have few alternative places to develop. This lengthy process means that developers are unable to meet demand when it increases, but can finally bring homes to the market about the time that demand declines. Volatility is good if you are lucky enough to buy low and sell high, but many people do not have a choice about when they buy and sell, which greatly increases the risk of homeownership.

While we have better data for housing than for other types of development, these same forces apply to retail, commercial, and other forms of development as well as housing. In combination, they make the Bay Area one of the least business-friendly regions of the country.

The Bay Area has a reputation of being a hotbed of innovation and business start-ups. Yet the reality is that the combination of growth boundaries, a glacial permitting process, and resistance to density within the boundaries slowed Bay Area growth; forced low- and even moderate-income people to move out; and discouraged businesses from moving to or expanding in the region. Yet Plan Bay Area would only make these problems worse by tightening urban-growth boundaries despite a projected 30 percent increase in population between 2010 and 2040.

At the same time as the Bay Area was making housing unaffordable, it was building a network of rail transit, including the BART system, Muni and VTA light rail, Caltrain, and the Altamont Commuter Express. Elsewhere, I estimate that the total capital costs for these rail lines was more than $15 billion, yet they did little to improve the region's transportation system.[2]

In fact, Federal Transit Administration data reveal that, since at least 1982, the region's transit ridership has dramatically declined. Bay Area transit agencies carried more than 530 million trips in 1982, not counting what were probably around 6 million trips carried on Southern Pacific commuter trains (later taken over by CalTrain) as they weren't included in data published by the Federal Transit Administration. By 2011, they carried only 461 million trips.

An agency-by-agency comparison of ridership in 1982 and 2011 shows what happened. BART ridership increased by 52 million trips during this time. San Francisco light rail grew by 7 million trips and San Jose light rail carried 10 million trips in 2011 but none in 1982. In addition, CalTrain probably gained about 6 million trips over what Southern Pacific carried in 1982. The Altamont Commuter Express carries less than a million trips per year, for a total gain in rail ridership of about 76 million annual trips.

During the same period, however, Muni lost 79 million bus trips; A-C Transit lost 63 million bus trips (about 10 million of which were picked up by other agencies such as Central Contra Costa Transit); SamTrans lost 9 million trips; Santa Clara transit lost 6 million bus trips; and Golden Gate transit lost 4 million trips, for a total of 162 million lost trips. While a few bus agencies gained ridership, the net effect is a decline of about 75 million trips, depending on how many trips Southern Pacific carried in 1982. The apparent reason for the decline is that MTC has invested in BART and other rail transit at the expense of maintaining and improving the region's bus systems, a policy that led one critic to call BART a "vampire [that] sucks the lifeblood out of every transit agency with which it comes in contact."[3]

When taking the region's population growth into account, per capita transit trips declined from 100 in 1982 to 64 in 2011. Moreover, transit's share of commuting has also declined. The 1980 census found that 11.6 percent of Bay Area commuters took transit to work. In 1990 and 2000, it was only 10.1 percent. The 2010 census found a slight recovery to 10.6 percent. But between 1980 and 2010, the share of commuters who drive to work increased from 80.7 percent to 82.1 percent. At the same time, according to the Texas Transportation Institute, the cost of congestion more than octupled between 1982 and 2007. While the cost declined somewhat after 2007, that was only because of the recession, not to transit, whose ridership declined between 2007 and 2011.[4]

A 36 percent decline in per capita ridership and a loss of market share of commuters, transit's core market, has to be regarded as a huge failure. Yet Plan Bay Area blithely proposes to continue the same policy of expanding high-cost rail service at the expense of buses and highways.

## Plan Bay Area: A Continuation of Failure

As described in Table 3.1-1 of the draft environmental impact report (DEIR), to prepare Plan Bay Area, planners identified more than two dozen policies that could vary among the alternatives. These include:

- Zoning policies including existing, PDA focused, and TPP focused zoning;
- Growth boundaries including existing and stricter;
- Subsidies, including subsidies to PDAs, urban cores, and TPPs;
- Land-use incentives including OneBayArea grants, CEQA streamlining, and TPP redevelopment incentives;
- Road plans including the committed road network only, preferred network, preferred with reduces express lanes, and preferred with no high expansion;
- Transit plans including committed only, preferred, more funds for BART and AC transit, and more funds for all agencies except BART, Muni, and Caltrain;
- Fee policies including fees on high VMT areas, increased peak tolls on the Bay Bridge, and a VMT tax;
- Parking policies including no change and reducing minimum parking requirements;
- Climate initiatives, including public chargers for electric vehicles, electric vehicle purchase incentives, car sharing, vanpool incentives, clean vehicles feebates, smart driving strategy, and commuter benefits ordinance.

Planners' biases are revealed by several important policies that were not even considered. For example, although "existing" and "stricter" growth boundaries were considered, the option of less-restrictive boundaries was not. Although the options of MTC's preferred road network or less-extensive networks were considered, a more-extensive road network was not. Although 35 percent or more improvements to rail service were considered, the alternative of making similarly large improvements to bus service was not.

The next appropriate step in the planning process would be to estimate the cost of each of these policies and each policy's effects on greenhouse gas emissions, housing affordability, and other planning goals. Plan Bay Area planners, however, either skipped this step or failed to document it in the DEIR.

Instead, as described on pages ES-7 and ES-8 of the DEIR, they then combined these policies, almost at random, into five alternatives:

1. "No Project," meaning no changes in land-use patterns and no transportation improvements other than those already approved by May 1, 2011;
2. "Proposed Plan," which puts most housing and job growth in priority development areas (PDAs) and spends nearly 60 percent of funds available for transportation improvements on transit;
3. "Transit Priority Focus," which puts most housing and job growth in "transit priority project (TPP) areas" and spends even more on transit;
4. "Enhanced Network of Communities," in which "development is still generally focused around PDAs" and Bay Bridge tolls are increased to provide more money for transit;

5. "Environment, Equity, and Jobs" would emphasize development in both PDAs and in "jobs-rich, high- opportunity TPPs not currently identified as PDAs" and charge vehicle-mile fees to provide more money for transit.[5]

While this might at first glance appear to be a wide range of alternatives, in fact, it is not.

- Table 3.1-1 shows that all alternatives except No Project make urban-growth boundaries even more restrictive than they are today and meet housing demand by targeting numerous neighborhoods for densification. They differ only in which neighborhoods they target. (No Project densifies within existing urban-growth boundaries but does not target specific neighborhoods.)
- According to table 3.1-7, all of the alternatives except No Project increase rail service by more than 35 percent (No Project is 20 percent), while the most any alternative increases bus service is 24 percent even though planners anticipate a 30 percent growth in the region's population.
- Also according to table 3.1-7, and in spite of the projected 30 percent growth in population, none of the alternatives contemplate more than a 3.3 percent increase in the region's road network (counting freeways, expressways, arterials, and collectors), or more than a 10 percent increase in the region's freeway lane miles.

Densification and rail transit are needed, planners say, to reduce greenhouse gas emissions. Not only is this highly debatable, the reality is that planners' biases towards densification and transit long preceded the issue of greenhouse gases.

## Plan Bay Area Is Biased Towards Density

Numerous surveys have shown that most Americans aspire to low-density housing and lifestyles.[6] Yet for decades, urban planners have believed that higher-density housing is somehow superior. Urban Land Institute researcher Douglas Porter describes this as a "gap between the daily mode of living desired by most Americans and the mode that most city planners . . . believe is most appropriate." While most Americans, Porter admits, "want a house on a large lot," planners believe such low densities are "expensive in terms of public and private infrastructure costs, quality of life, and environmental damage." The question Porter asked was: how do planners convince people to live the way planners think they should live? Porter's answer was regional plans like Plan Bay Area.[7]

Density is a solution in search of a problem. Before climate change was a concern, planners supported densification in order to improve people's sense of community; save energy; reduce air pollution; improve health and reduce obesity; protect farms and open space; and reduce traffic congestion. In fact, the correlation between density and any of these factors is weak and, in some cases, exactly the opposite of what planners think it is. Yet this hasn't changed planners' goal of increasing population densities.

Ironically, thanks to infill development since the establishment of urban-growth boundaries, San Francisco-Oakland is already the second-densest urban area in the country. According to the 2010 census, the densest is Los Angeles-Long Beach-Anaheim, at 7,000 people per square mile. San Francisco-Oakland is 6,266 people per square mile. San Jose, at 5,820 people per square mile, is third. New York-Newark, at 5,320 people per square mile, is only number five.[8] While New York City may be denser than San Francisco, the Bay Area has denser suburbs.

The 2010 density of all urban areas in the Bay Area is 4,743 people per square mile. This is almost exactly twice the average density of all U.S. urban areas (areas of more than

2,500 people).[9] The nation's largest urbanized areas that have maintained housing affordability, including Dallas-Ft. Worth, Houston, and San Antonio, have densities approaching 3,000 people per square mile. Some have lower densities, but densities above 3,000 people per square mile seem to be associated with unaffordable housing: in 2010, no urbanized area (areas of more than 50,000 people) denser than 3,000 people per square mile had median home prices less than 2.5 times median family incomes.[10]

Despite existing densities, Plan Bay Area calls for densifying the region still further. Under the plan, all non-agricultural development will take place "within the urban footprint (existing urban development and urban growth boundaries)."[11] Since the plan is projecting 30 percent more people by 2040, virtually all of whom will live in urban areas, 2040 urban densities will grow by about 30 percent.[12]

To accommodate 30 percent more people without increasing the area of developed land, table 2.3-2 of the DEIR indicates that, by 2040, there will be 169,100 fewer single-family detached homes, 380,000 more townhouses, and 489,100 more multi-family dwellings. In other words, one out of every nine single-family detached homes will be demolished and replaced with an average of 5.1 attached or multi-family homes.

Plan Bay Area also calls for 77 percent of new housing to locate in "priority development areas" (PDAs) located along major transit corridors. These PDAs occupy just 5 percent of the region's land area, but are also expected to provide 63 percent of new jobs.[13] To accommodate 77 percent of new residents, the PDAs would have to have average population densities of 4,700 people per square mile on top of whatever population they have today.

Plan Bay Area claims that the planned reduction of single-family detached homes from 56 percent to just 39 percent of the region's housing stock reflects changes in housing preferences. Supposedly, large numbers of retiring baby boomers and young households with no children will prefer to live in high-density, mixed-use areas rather than low-density suburbs. In support of this idea, they cite work by University of Utah planner Arthur Nelson.[14]

Nelson's work, however, is not credible. As described in a 2006 article on future housing preferences in the *Journal of the American Planning Association*, he based his projections of future demand "on interpretations of surveys" reported in a paper by urban planners Dowell Myers and Elizabeth Gearin[15] In the same issue of the *Journal*, an article by University of North Carolina professor of urban planning Emil Malizia critiqued Nelson's claims.

Malizia pointed out that the surveys on which Nelson based his work "may not be terribly reliable" because the samples "are self selected rather than random" and may be "heavily influenced by the data collection method."[16] The surveys asked questions such as whether people would "approve of having townhouses built in their neighborhoods" and whether they might want to live in one. A mere 17 percent said they might to live in one, but since that was more than the share of Americans already living in townhouses, Nelson concluded there was a shortage of this type of housing.

Malizia also observed that Nelson advocated "financial incentives and concessions" to persuade developers to build high-density housing, a concept included in Plan Bay Area. Yet, Malizia pointed out, "If it is true that consumers prefer and can afford new forms of development, real estate developers and investors will respond; these markets are not that inefficient."[17]

In other words, if it is true that there is a growing demand for high-density housing, then one way to meet that demand would be to reduce regulation and allow builders to build for the market. Plan Bay Area instead would mandate and subsidize construction of high-density housing whether there is a market for it or not.

Table 2.3-2 uses the term "demand" to imply that, by 2040, people won't want those 169,000 single-family detached homes. This, however, betrays planners' lack of understanding of fundamental economic concepts such as demand. Demand is not a point and cannot be expressed as a single number such as 1,365,900 (the number of single-family detached homes that the DEIR says Bay Area residents will "demand" in 2040). Demand is a line that shows the various quantities of something that people would buy at various prices. If the government artificially makes something very expensive, then the quantity that people will demand at that price will be low. But this doesn't mean, as the DEIR and Arthur Nelson imply, that public preferences for single-family detached homes have changed.

Japan is one of the most crowded countries in the world, and also has an aging population that Nelson would predict would prefer living in multi-family housing. Yet 55 percent of Japanese households live in single-family detached homes.[18] In order to fit 30 percent more people inside of more restrictive urban-growth boundaries, Plan Bay Area planners know they have to reduce the share of Bay Area households living in single-family detached homes to just 39 percent, or 16 percent less than Japan. So they use the subterfuge of "demand" as an excuse to do so.

The reality is that, if housing were more affordable, a far greater share of Bay Area residents would prefer single-family detached homes. The fact that Plan Bay Area proposes to subsidize densification of PDAs shows that planners understand that, even at the Bay Area's unaffordable housing prices, the demand for high-density housing is not sufficient to support the densification required by the plan.

Plan Bay Area's policy of targeted densification was pioneered by planners in the Portland, Oregon, area. Like the Bay Area, Portland-area planners drew an urban-growth boundary in the 1970s. Unlike the Bay Area, Portland has a strong regional government, known as Metro, which in the mid-1990s gave population targets to each of 27 municipalities in the region and specifically targeted several dozen neighborhoods and numerous corridors for redevelopment at higher densities.[19]

Bay Area planners may believe that such targeted densification will help relieve the region's housing affordability problems. After all, Portland housing is less unaffordable than the Bay Area's: At the height of the recent housing bubble, Portland-area median home prices were about 4.5 times median family incomes, instead of 9 to 11 times as they were in the Bay Area.

A closer look suggests that Portland's relative affordability has little to do with its densification policies. For one thing, the Portland urbanized area has only about 3,500 people per square mile—well under the Bay Area's average of more than 4,700 people per square mile. Second, Portland's densification programs started only recently, since the late 1970s Portland has always been more affordable than the Bay Area, so densification is probably less important than other factors.

The most important other factor is that Portland has "safety valves" in the form of less-regulated areas located nearby where Portland-area workers could buy homes at affordable prices. Clark County (Vancouver), Washington has far less land-use regulation, and between 1990 and 2010 its population grew almost twice as fast as counties on the Oregon side of the Portland-Vancouver metro area. Salem, Oregon—45 miles south of Portland—has an urban-growth boundary but was never as strict as Portland, so its population also grew rapidly between 1990 and 2010, overtaking Eugene as Oregon's second-largest city.

By contrast, the Bay Area's "safety valves" are located in Modesto, Stockton, and other Central Valley cities some 80 to 90 miles away from most Bay Area employment centers. While these areas rapidly grew during the housing boom of the early 2000s, their distance from Bay Area jobs and the land-use regulation that they imposed on local developers meant that they had little effect on Bay Area housing prices. In short, there is little reason to believe that targeted densification will make Bay Area housing more affordable.

Plan Bay Area argues that one advantage of multi-family homes is that they use less energy than single-family. "Multi-family residential units, when compared to single family residential units, are 44 percent more efficient on a per unit basis in terms of consumption of electricity and 35 percent more efficient with natural gas consumption."[20] What the plan doesn't say, however, is that this is solely because multi-family units are smaller than single-family homes.

According to the U.S. Department of Energy, single-family detached homes use 30 percent *less* energy per square foot than multi-family homes. This is actually an underestimate because it doesn't count the energy needed to light, heat, and air condition hallways, lobbies, and other common areas in multi-family structures. In addition, household sizes in single-family homes average about 26 percent more than in multi-family, which on a per-person basis offsets most of the energy savings claimed by Plan Bay Area per household.[21]

Plan Bay Area's bias towards density is also based on an assumption that people living in higher densities drive less. Most studies of the relationship between driving and density measure the number of trips or vehicle miles of travel by household in areas of different densities. But households in higher density areas tend to be smaller, so differences in per capita driving among areas of differing densities are smaller than differences in per household driving.

Most of these studies also fail to take into account the self-selection problem, which is that people who prefer to drive less tend to live in higher density areas. This does not mean that increasing densities will lead other people to drive less.

In reviewing the literature of the relationship between the "built environment" and driving, economist David Brownstone of the University of California at Irvine found that most studies "make no attempt to control for self-selection." The ones that did typically found that the relationship between density and driving was small. Overall, "There is evidence that there is a statistically significant link between aspects of the built environment correlated with density and VMT," Brownstone concluded, but "the size of this link is too small to be useful" in saving energy or reducing greenhouse gas emissions.[22]

## Plan Bay Area Is Biased Towards Transit

Plan Bay Area would dedicate 62 percent of transportation funds to transit and 38 percent to roads even though transit carries only 3.5 percent of the region's passenger travel and less than 11 percent of the region's commuters to work. The assumptions behind this split are that spending more money on transit will get people to take transit instead of driving and that transit emits significantly less greenhouse gases than cars. Neither assumption is true.

The DEIR projects 40 to 60 percent increases in per capita transit ridership under all alternatives except No Project, and even No Project projects a 25 percent increase.[23] Based on past performance, however, such increases are unlikely. As shown above, despite billions of dollars spent on transit over the past several decades, per capita transit ridership has declined by 36 percent since 1982.

Even if Plan Bay Area could increase per capita transit ridership, doing so is not likely to significantly reduce greenhouse gas emissions. While transit emits slightly less greenhouse gases than driving today, under the Pavley standards, cars will soon be greener than transit.

The Federal Transit Administration's National Transit Database indicates that transit operations consumed an average of 3,443 BTUs per passenger mile in 2010.[24] For the same year, the Department of Energy says that the average car consumed 3,447 BTUs per passenger mile.[25] The 0.12 percent difference between the two is less than the sampling error for these two numbers. Cars and transit also both emit about 250 grams of carbon-dioxide-equivalent greenhouse gases per passenger mile.

Light trucks consumed more energy, about 4,200 BTUs per passenger mile, which is about 300 grams of greenhouse gases per passenger mile. But there are several reasons to believe that both cars and light trucks will soon be more efficient and cleaner than transit.

First, while rail transit uses less energy per passenger mile than buses, the total lifecycle costs of rail transit are much larger, relative to the operational costs, than for highway transportation. According to an analysis by researchers at the University of California at Berkeley, "total life-cycle energy inputs and greenhouse gas emissions contribute an additional 63% for on road, 155% for rail, and 31% for air systems over vehicle tailpipe operation."[26] In other words, the full environmental costs of rail are 155 percent greater than the operational costs while the full environmental costs of highway transport are only 63 percent greater than the operational costs.

In 2010, rail transit operations, including light rail, heavy rail, and commuter rail, used 2,676 BTUs per passenger mile. This means the full, life-cycle energy costs of rail transit are more than 6,600 BTUs per passenger mile, while the full, life-cycle costs of driving a car are 5,600 BTUs per passenger mile. Rail transit still beats light trucks, but barely, as the latter consume 6,800 BTUs per passenger mile.

The second factor that must be considered is that cars and light trucks are rapidly becoming greener, while transit is improving slowly, if at all. Average auto fuel economy has improved by 40 percent in the last 40 years, while transit's fuel economy has actually gotten worse.[27]

Based on the DEIR's projections of miles of driving in table 3.1-8 and greenhouse gas emissions in table 3.1-28, the Pavley standards will reduce average per-mile emissions by 26 to 28 percent, which is roughly the same as improving fossil fuel economy by the same amount. This suggests the average automobile on the road in 2040, including both cars and light trucks will use only about 2,700 BTUs and emit about 190 grams per passenger mile. Adding 63 percent to get the total life-cycle costs means that autos will use about 4,400 BTUs and emit about 310 grams of carbon dioxide per passenger mile, both of which are less than transit today.

While bus transit fuel economy might improve slightly between now and 2025, rail transit is not likely to get any better. This is because rail systems have long lifespans and, once a technology is selected, it is very expensive to replace with something that is more fuel-efficient. "Autos and buses have relatively short life cycles, modest capital costs and have autonomous vehicles independent from the guideway; thus, they can enable relatively rapid integration of state-of-the-art technologies," says University of South Florida transit expert Steve Polzin. "Modes where the vehicle and guideways are integrated systems may be far more difficult or expensive to upgrade to newer, more efficient technologies."[28]

## Plan Bay Area Is Not Cost Effective

If reducing greenhouse gas emissions is really the high priority that SB 375 and the plan say it is, then it is equally critical to find the most cost-effective ways of achieving that goal. Any money spent on a less-than-cost-effective means of reducing emissions means less money available to reduce them using more cost-effective tools.

Plan Bay Area pays lip service to developing a "cost-effective" transportation system.[29] Yet there is nothing cost-effective about the current or proposed Bay Area transportation network. The high cost of rail is revealed by Plan Bay Area's proposal to spend $159 billion on transit maintenance and only $94 million on road maintenance.[30] In 2010, about two-thirds of Bay Area transit maintenance spending was on rail transit, which suggests that about $106 billion of transit maintenance is needed for rail systems.[31] The Bay Area has less than 700 directional route miles of rail lines but more than 20,000 lane miles of freeways, expressways, arterials, and collectors.[32] Yet Plan Bay Area proposes to spend less maintaining those 20,000 lane miles of roads than some 700 miles of track.

Thus, even if expanding the Bay Area's transit systems could save a small amount of energy and slightly reduce greenhouse gas emissions, the high cost of doing so would not be worth it. A 2007 report from McKinsey & Company suggests that programs to abate greenhouse gas emissions are worthwhile only if they cost less than $50 per ton of abated carbon dioxide.[33] Spending more money on transit, if it reduces greenhouse gas emissions at all, would do so at a cost of thousands of dollars per ton. Yet Plan Bay Area calls for spending $21 billion on transit improvements compared with just $15 billion on highway improvements.[34]

The McKinsey report suggests a variety of ways of cost-effectively reducing greenhouse gas emissions, yet none are contemplated in Plan Bay Area. My own analysis of densification and rail transit, the two central features of Plan Bay Area, are that they would cost thousands of dollars per ton, many times more than McKinsey's $50-per-ton cost-effectiveness threshold.[35]

A close analysis of table 3.1-29 in the DEIR reveals that Plan Bay Area is far from cost effective in reducing greenhouse gas emissions or meeting any other goal. This compares greenhouse gas emissions in 2010 with emissions in 2040 under each of the alternatives. Emissions are broken down by land-use and transportation sources.

According to the table, the California Air Resources Board's (ARB) 2008 scoping plan will reduce land-use related emissions by 9.6 billion tons per year under all the alternatives. By comparison, the densification required by Plan Bay Area will reduce emissions by only 131 million tons. This doesn't mean the ARB's scoping plan is necessarily cost effective, but it is certainly far more effective than densification.

On the transportation side, improved fuel efficiency of cars, trucks, and buses is expected to reduce greenhouse gas emissions by 2.7 billion tons per year. (Emissions from "other vehicles," including trains and ferries, are expected to increase.) Full implementation of MTC's climate policy initiative is projected to reduce emissions by 1.6 billion tons. By comparison, Plan Bay Area's efforts to get people to drive less reduces emissions by only about 330 million tons. Again, this doesn't mean that all parts of MTC's climate policy initiative are necessarily cost effective, but the initiative is more than twice as effective as Plan Bay Area's densification and transit strategies at what is likely a far lower cost.

The No-Project alternative, which assumes implementation of the ARB scoping plan, improved auto fuel economy, and only partial implementation of MTC's climate policy initiative, reduces greenhouse gas emissions by 12.2 percent. Adding full implementation of MTC's climate policy initiative would reduce greenhouse gas emissions by a total of 14.4 percent. Adding Plan Bay Area's densification strategy reduces emissions by only 0.3 percent more. Adding Plan Bay Area's efforts to get people to drive less reduces emissions by 0.7 percent more.

Table One
Effectiveness of Greenhouse Gas Emissions Strategies

| Strategy | Billions of Tons | Change from 2010 |
|---|---|---|
| 2010 baseline | 48,846 | |
| No Project in 2040 | 42,895 | –12.2% |
| No Project plus full MTC Climate Initiative | 41,813 | –14.4% |
| Plan Bay Area Land-Use Strategies | 41,682 | –14.7% |
| Plan Bay Area Transportation Strategies | 41,344 | –15.4% |

In other words, although Plan Bay Area's preferred alternative reduces emissions by 15.4 percent below their 2010 levels, only 1 percent of that reduction is due to Plan Bay Area itself. To be fair, some of reduction in driving may be due to Plan Bay Area's densification strategy, but that only means that Plan Bay Area's transit investments are projected to be even less effective at reducing greenhouse gas emissions.

All of these numbers are projections, of course, and there is little reason to suspect that they will be accurate. All of the alternatives except No Project project a 40 to 60 percent increase in per capita transit ridership, and even No Project projects a 25 percent increase. Yet past efforts by MTC and ABAG have failed to increase per capita transit ridership, reduce per capita driving, or increase transit's share of travel.

It is entirely possible that Plan Bay Area could lead to greater emissions than a do-nothing alternative, rather than less. For example, concentrating 77 percent of new development in 5 percent of the region's land area is likely to significantly increase traffic congestion in the PDAs. Such increased congestion will waste fuel and produce more greenhouse gas emissions. Moreover, the emissions figures in table 3.1-29 only include the operational costs of transportation. As previously noted, the full life-cycle costs of rail transport are much greater than the operating costs, so table 3.1-29 underestimates the effects of rail expansions relative to highway expansions.

Incidentally, Plan Bay Area's claim that the No Project alternative does not meet the state mandate for a 15 percent reduction in per capita car and light truck emissions is simply wrong. According to table 4 of Plan Bay Area, No Project reduces per capita auto emissions by 8 percent, while the preferred alternative reduces them by 18 percent. However, as described in table 3.1-28 of the DEIR, this conclusion was reached assuming that the Pavley fuel standards did not exist.

Table 3.1-29, which takes the Pavley standards into account, shows that per capita passenger vehicle emissions will fall by at least 37 percent under No Project and 41 percent under the preferred alternative. MTC's climate policy initiative will reduce vehicle emissions even further, though it isn't possible to assess how much of that reduction is due to passenger vehicles. But it is clear that all alternatives meet the state mandate. In any case, the main difference in emissions between the No Project alternative and the other four is that the No Project alternative only partially implements MTC's climate policy initiative, while most of the others fully implement it. Plan Bay Area's other land-use and transportation policies have relatively little effect on per capita greenhouse gas emissions.

## Plan Bay Area Fails to Make Housing Affordable

Thanks to previous land-use planning efforts, the Bay Area is one of the least affordable housing markets in the world.[36] Though Plan Bay Area sets adequate housing as one of two mandatory targets, it fails to do more than tinker at the edges of the region's housing affordability problem.

The plan sets a target of reducing "by 10 percentage points (to 56 percent, from 66 percent) the share of low-income and lower-middle income residents' household income consumed by transportation and housing."[37] But it admits that it not only fails to reach this target, it "moves in the wrong direction" with the share of income needed to cover transportation and housing rising to 69 percent for low- and lower-middle-income residents.[38]

The plan's main tools to address this issue are targets for communities in the region to accept new housing and subsidies to low-income housing. But housing affordability is not just a problem for low- and lower-middle income families. At $156,000, Palo Alto had the highest median family income of any city in the Bay Area in 2011, yet it also had median housing prices of more than $1 million, or well over 6 times family incomes.[39]

Subsidies for low-income housing are not going to solve the region's housing problems. In fact, many subsidies and affordability mandates actually make those problems worse by driving up the overall cost of housing. For example, numerous Bay Area communities have imposed housing mandates requiring builders to sell or rent a specified portion of new housing for "affordable" rates. The result is less overall construction and higher prices for the non-affordable units that are built. When the affordability mandates push up the prices of new homes, the prices of used homes follow making housing less affordable for almost everyone.[40]

High-density housing won't solve the problem either. While some people, mainly young singles and childless couples—though not necessarily a majority of those—are attracted to dense, mixed-use developments, they are a small minority. For most new Bay Area residents, such high-density developments will be second-class housing: smaller, with less privacy, more noise, no room for expansion as families grow, and more subject to crime. This means they will continue to aspire to live in single-family homes that planners have made unaffordable to most residents who are not fortunate enough to already own one.

While Plan Bay Area claims to meet the state mandate that 100 percent of residents can be housed within the region, this is just a numeric exercise of assigning density targets to each city in the region. Whether those targets can be reached is another matter entirely, especially if fewer than 538,000 households—the plan's target for PDAs—are willing to live in such high-density areas.[41]

## Plan Bay Area Ignores Trade-Offs

Bay Area residents have a wide range of needs, preferences, and priorities, and Plan Bay Area considers only a few of them. By failing to fully evaluate the more than two dozen policies being considered in the plan, Plan Bay Area ignores the trade offs between these policies, some of which may be more important to residents than they realize.

For example, Plan Bay Area takes it for granted that roughly 80 percent of land in the nine-county area should be preserved as open space. Currently, the plan says, only about 18 percent of the nine-county area is developed, and the plan calls for all new non-agricultural development to remain within this area.[42] The 2010 census found that 21 percent of the nine-county area is "urbanized"; the difference may be parks included in the Census Bureau's definition of urbanized.[43]

The trade off of keeping all new development in a minimal area is that this policy has produced one of the world's least affordable housing markets. If the region's population density had been allowed to remain at 3,000 people per square mile—the density at which major urban areas still have affordable housing—the amount of developed land would have increased from Census Bureau's 21 percent to just 33 percent. Even with population growth through 2040, densities could remain this low while still allowing well over half the region to remain as open space.

Plan Bay Area claims that adequate housing is a "mandatory" target while open space preservation is a "voluntary" target. But in fact it treats open space as mandatory and trades off affordable housing in order to preserve that open space, failing to meet its target that low- to moderate-income people are able to reduce the shares of their income going for housing and transportation costs. This is unfair both to future homebuyers and the owners of land that is excluded from development.

Plan Bay Area also ignores the trade offs between high-density housing and public safety. Contrary to popular belief, density itself does not lead to higher crime, but the design features associated with higher densities often can. Architect Oscar Newman's 1973 book, *Defensible Space*, first identified the design features that make developments more susceptible to crime. He found that the most important factor in reducing property crime was to reduce what he called "permeability," that is, the ability of strangers to enter properties.[44]

For example, a high-rise luxury apartment building with one entrance staffed by a security guard would have low permeability. But mid- and high-rise apartments built for low- or middle-income families often have multiple entrances and no security guards, making them very permeable. A neighborhood of homes with private backyards would be less permeable than one with alleys behind the homes, offering potential burglars more access points to the home. Mixed-use developments and developments with lots of common areas are more permeable than single-use developments with mainly private property because it is not always easy to tell if a stranger in a mixed-use development or common area has a legitimate purpose in being there or not.

Unfortunately, most of the things planners want to build into PDAs and transit-oriented developments—such as mixed uses, alleys, and common areas—increase permeability and make those developments more subject to crime. A study of a "New Urban" development in Britain found that it had five times as much crime and cost police departments three times as much to keep secure as a development designed to minimize permeability.[45]

Crime is only one of many issues that influence people's housing decisions. Others are the quality of schools; proximity to friends and relatives; access to transportation; and other neighborhood amenities. Ironically, considering that planners would prefer that everyone lived close to work, close proximity to work is *not* a major factor in people's housing decisions. In fact, studies by University of California (Davis) researchers have found that people prefer to live some distance from work so they can adjust to a work or home mindset as they commute.[46]

By focusing mainly on planners' desire to reduce per capita driving, Plan Bay Area oversimplifies the complexity of real life and the wide range of people's personal tastes and preferences. The result is a plan that intrusive and authoritarian without any redeeming values.

## Conclusions

Plan Bay Area considers more than two-dozen policies aimed at reducing greenhouse gas emissions and making housing more affordable. Yet the policies it adopts are not cost-effective at reducing emissions and are not effective at all in making housing affordable. Other policies that might have been more effective weren't even considered. These failings can be traced directly to inadequacies in the planning process.

In a rational planning process, planners should identify, without prejudice, a wide range of policies that might contribute to the goals of the plan. They should then estimate the cost of each of the policies and their effects on emissions, affordability, and other issues. This would allow them to develop a plan by selecting a blend of the policies that are most cost-effective at meeting the key goals of the plan.

Instead, planners started out by assuming that the plan would adopt certain policies, including densification and a 35 percent increase in rail transit service, that may not contribute to the goals at all and are certainly unlikely to be cost-effective ways of reducing greenhouse gas emissions.

Although planners failed to do a cost-effectiveness analysis of these policies, it is possible to estimate from table 3.1-29 that densification and improved transit service together will reduce greenhouse gas emissions by less than 1 percent. The Plan also admits that it fails to make housing more affordable for low- and lower-middle-income people, which almost certainly means housing will be less affordable for everyone who does not already own a home.

How can planners justify an enormously expensive plan that disrupts numerous neighborhoods in the region in order to reduce greenhouse gases by 1 percent? The answer is that they cite a state law requiring a 15 percent reduction in per capita emissions from automobiles—but then ignore another state law that mandates improvements in fuel economy that, by itself, will more than meet this goal.

This means Plan Bay Area is not only poorly planned; it is dishonest. The entire plan should be scrapped and restarted, preferably at the local level rather than the regional level.

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# Curriculum Vitae for Randal O'Toole

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## Books

*American Nightmare: How Government Undermines the Dream of Homeownership*, Cato Institute, 2012

*Gridlock: Why We're Stuck in Traffic and What to Do About It*, Cato Institute, 2010

*The Best-Laid Plans: How Government Planning Harms Your Quality of Life, Your Pocketbook, and Your Future*, Cato Institute, 2008

*The Vanishing Automobile and Other Urban Myths: How Smart Growth Harms American Cities*, Thoreau Institute, 2001

*Reforming the Forest Service*, Island Press, 1988

## Selected Other Publications

"The Great Streetcar Conspiracy," Cato Institute Policy Analysis No. 699. June 14, 2012.

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"Crony Capitalism and Social Engineering: The Case against Tax-Increment Financing," Cato Institute Policy Analysis No. 676. May 18, 2011.

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"The Greatest Invention: How Automobiles Made America Great," American Dream Coalition, September, 2006.

## Education

1977–1980: Graduate work in urban planning and economics at the University of Oregon; no degree.

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# Policy Analysis

No. 606 December 6, 2007

Routing


# The Planning Tax
## The Case against Regional Growth-Management Planning


by Randal O'Toole


## Executive Summary


Regional growth-management planning makes housing unaffordable and contributes to a business-unfriendly environment that slows economic growth. The high housing prices caused by growth-management planning were an essential element of the housing bubble that has recently shaken our economy: for the most part, this bubble was limited to urban regions with growth-management planning.

In 2006, the price of a median home in the 10 states that have passed laws requiring local governments to do growth-management planning was five times the median family income in those states. At that price, a median family devoting 31 percent of its income (the maximum allowed for FHA-insured loans) to a mortgage at 6 percent, with a 10 percent down payment, could not pay off the mortgage on a median home in less than 59 years. In contrast, a median home in the 22 states that have no growth-management laws or institutions cost only 2.7 times the median family income. This meant a family could pay off a home in just 12.5 years.

Growth-management tools such as urban-growth boundaries, adequate-public-facilities ordinances, and growth limits all drive up the cost of housing by artificially restricting the amount of land available or the number of permits granted for home construction. On average, homebuyers in 2006 had to pay $130,000 more for every home sold in states with mandatory growth-management planning than they would have had to pay if home price-to-income ratios were less than 3. This is, in effect, a *planning tax* that increases the costs of retail, commercial, and industrial developments as well as housing.

The key to keeping housing affordable is the presence of large amounts of relatively unregulated vacant land that can be developed for housing and other purposes. The availability of such low-cost land encourages cities to keep housing affordable within their boundaries. But when state or other planning institutions allow cities to gain control over the rate of development or rural areas, they lose this incentive, and housing quickly becomes unaffordable. States with growth-management laws should repeal them, and other states should avoid passing them.


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*Randal O'Toole is a senior fellow with the Cato Institute and author of the new book* The Best-Laid Plans: How Government Planning Harms Your Quality of Life, Your Pocketbook, and Your Future.


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**Jane Jacobs wryly observed that a region is "an area safely larger than the last one to whose problems we found no solution."**

## Introduction

More than two out of three Americans live in an urbanized area, which the Census Bureau defines as "a densely settled area that has a census population of at least 50,000."[1] Urbanized areas are identified by the name of the most prominent city or cities in the area, such as St. Louis or Minneapolis–St. Paul. But, in fact, most urban areas are made up of dozens, and sometimes hundreds, of municipal units of government, including cities, towns, villages, counties, and special districts of various kinds.

What is the best way to govern these urbanized areas? Should cities and other municipal governments be allowed to compete with one another for residents, businesses, and funding from state and federal governments? Or should planning and certain other regional functions be given to a regional government that oversees each urban area?

Many planners and some economists have argued that regional governments are better suited than local governments to solving problems such as housing. Urban planners say that regional governments can make cities and their suburbs more livable and affordable for both businesses and residents. Planners specifically oppose *leap-frog development*, in which a developer builds housing or other development on land that is physically separated from existing urbanized land. More recently, planners have tried to discourage all greenfield development, even if it is physically next to existing urbanized land, preferring instead *infill* development, or development of vacant parcels within an urban area.

One of the major claims for infill development is that it is less expensive than development on the urban fringe. A 2002 report from the Rutgers University Center for Urban Policy Research titled *The Costs of Sprawl—2000* estimated that low-density suburban development at the urban fringe imposes about $11,000 more in urban-service costs on communities than more compact development.[2]

To avoid such costs, planners favor a form of planning known as *growth-management planning*, which uses urban-growth or urban-service boundaries, rules requiring adequate financing for urban services before the issuance of building permits, and similar tools to direct growth to certain areas and away from areas designated as preserves or reserves.

Economists have focused on specific urban problems. Harvard economist Edward Glaeser sees regional governments as a solution to housing affordability problems. "Land use regulations seem to drive housing supply and determine which regions are growing," Glaeser observes. "A more regional approach to housing supply *might* reduce the tendency of many localities to block new construction" (emphasis added).[3]

Despite these claims and speculations, there has been little research showing whether regional governments can actually make urban areas more attractive and more affordable. As UC Berkeley political scientist Margaret Weir observes, the literature on regional governments "does not connect regional processes with regional outcomes, [so] we do not know enough about what makes regions successful."[4]

Another argument for planning is that there are certain problems that are regional, and only a regional government staffed by regional planners can solve those problems. This argument has been strongly promoted by former Albuquerque mayor David Rusk.[5] In fact, most of the supposedly regional problems—including housing, open space, solid waste, infrastructure, and transportation—can easily be handled at the local level. The few problems that are difficult to solve locally are not made any easier by magnifying those problems to a regional scale. As Jane Jacobs wryly observed, a region is "an area safely larger than the last one to whose problems we found no solution."[6]

A close look at the data for America's urbanized areas reveals that regional growth-management planning generally does not produce the benefits claimed for it. States and regions with strong regional governments tend to have the least affordable housing and are often growing more slowly than regions with weak regional governments. This suggests that state and local officials should dismantle or avoid regional governments, and in particular regional growth-management planning.

## A History of Regional Government

Regional government was a moot point during most of the 19th century, when urban Americans nearly all lived in cities and those cities readily annexed new developments that took place on their fringes. But in 1873, Brookline, Massachusetts, became the first suburb to reject a major city's offer to be annexed.[7] This started a trend that soon led to a clear split between the center cities and their suburbs.

By the mid-20th century, many suburbanites viewed the cities as cesspools of corruption, and they didn't want to see their taxes going into the pockets of aldermen or their contractor friends. Most states did not allow cities to annex without the permission of the people being annexed, and that permission was often difficult to obtain.

Central city officials, meanwhile, complained that the average income of the people who moved to the suburbs was higher than the people left behind, which tended to mean lower tax revenues for the cities. The cities came to view suburbanites as parasites, enjoying the economic and cultural benefits of the cities without paying their full share of the costs.

Urban planners who advocated regional government were not primarily concerned with municipal finance. They spoke instead of "rapid and often chaotic growth," which they contrasted with their "visions of promoting orderly urban regions with planned communities and efficient infrastructure systems."[8] "Central cities and suburbs are interdependent and cannot survive in the present governmental and physical chaos," argued one planning professor.[9] The repeated use of vague terms like "chaos" and "order" suggests that planners were trying to make their ideas attractive to a broad range of people without explicitly stating just what their ideas really were.

Planners, however, had few tools that they could use to promote their idea of orderly growth, whatever that was. The first zoning codes, passed by New York City in 1919 and other cities soon after, focused on maintaining the existing character and quality of neighborhoods of single-family homes. When a real estate developer in Euclid, Ohio, challenged one of these zoning codes, it was overturned by lower courts as an unconstitutional taking of property without compensation. When the case reached the Supreme Court, the court rejected arguments by the city of Euclid that the code was needed to preserve the character of the neighborhood. However, the court agreed with the argument of an intervener that the code was a constitutional exercise of police powers to prevent nuisances.[10]

If zoning could be used only to prevent nuisances, then regional planners would have little ability to control growth. It might be easy to show that pollution-emitting factory in the middle of a residential neighborhood would be a nuisance, but it would be much harder to show that someone developing vacant land on the edge of a city was creating a nuisance.

Cities could exercise some control over development by limiting the expansion of urban services such as sewer and water. However, they could not prevent developers from providing their own sewer, water, and other services by creating special service districts or incorporating their own cities. As long as developers had such freedom, regional planners were helpless to direct or control new development.

One response was the idea of city-city or city-county consolidations. Such consolidations would give the central city greater control over what happened in areas that were previously outside of its jurisdiction. Before World War II, several cities were able to persuade some or all of their suburbs to consolidate, including New York City (1898), Denver (1902), and Honolulu (1907). But suburbs of Oakland, St. Louis,

**Cities view suburbanites as parasites, enjoying the economic and cultural benefits of the cities without paying their full share of the costs.**

**In the 1978 Penn Central decision, the Supreme Court authorized cities to take most of the economic value of private property without compensation.**

Pittsburgh, and several other regions rejected such consolidations. After World War II, Baton Rouge (1947), Newport News (1952), Virginia Beach and Nashville (1962), Jacksonville, Florida (1967), Anchorage (1975), Kansas City (1997), and Louisville (2003) all consolidated with their county governments. However, voters rejected many other proposed consolidations, including those in Birmingham, Miami, Albuquerque, Memphis, St. Louis, Portland, and Sacramento.[11]

Congress struck a blow for regional government when the Federal-Aid Highway Act of 1962 included a requirement that the various cities in urban areas work together on a "continuing, comprehensive and cooperative" transportation planning process. Similarly, the Housing and Urban Development Act of 1965 required urban areas to form "organizations composed of public officials . . . representative of the political jurisdictions within a metropolitan or urban region." Regions that wanted to receive federal transportation and housing grants had to meet these requirements, and the reasoning at the time was that it would be easier for federal agencies to allocate grants among a few hundred urban areas than to decide among proposals from tens of thousands of municipal governments.

The 224 urbanized areas at the time quickly formed *metropolitan planning organizations* (MPOs). Sometimes called "councils of governments," "regional planning commissions," or similar names, these MPOs typically are governed by elected officials from most or all of the cities and counties in the region. Initially, most MPOs were little more than committees with post office boxes, and they did little other than distribute federal transportation and housing grants to local governments. But over time, most have grown to employ dozens or hundreds of urban planners, and a few exercise near-dictatorial controls over planning and zoning of much of the land in their regions.

The Supreme Court gave planners a new tool in 1978 when it decided the case of *Penn Central v. New York City*. Penn Central wanted to build an office tower above its Grand Central Terminal, but New York City's historic landmarks law prevented it. The city did not claim that the office tower would create a nuisance. In essence, it argued instead that the building would change the character of the area. Penn Central argued that its passenger terminal lost money, and a rule prohibiting it from building an office tower was an unconstitutional taking of its property without compensation. The court sided with the city, saying that even if the terminal lost money, Penn Central should use its revenue from its other real estate to cover those losses.[12]

In short, the Supreme Court overturned the *Euclid* ruling and authorized cities to downzone people's property, effectively taking away most of the economic value of that property, without compensation, even if the downzoning was not needed to prevent a nuisance. That led to a dramatic escalation in regional planning and zoning.

Despite the federal laws, the real impetus behind the growth in regional government has been from state laws. Several states—notably California, Oregon, Washington, and Florida—have passed laws requiring some form of regional planning in some or all urban areas in the states. Other state legislatures have authorized, but not required, such planning. Many other states provide no framework for regional planning or governance. These differences make it possible to compare the effects of regional government on such things as housing affordability and growth.

## The Evolution of Growth-Management Planning

Until 1970, urban growth and development in the United States was driven almost entirely by landowners and developers who were responding to market demands for residential, commercial, retail, and industrial uses. Once an area was developed, cities used zoning to provide homeowners and other landowners assurance that the character of their neighborhoods would not dramatically change through the intrusion of some incompatible use. Vacant lands were either unzoned or placed in a low-density "holding zone" that cities would readily change when landowners or developers presented proposals to develop the lands.

Growing concerns over environmental issues combined with fears that existing residents were somehow subsidizing growth led to a transformation of planning starting in 1970. In that year, Ramapo, New York, a suburb of New York City, passed the first *adequate public facilities ordinance*, also known as a *concurrency* ordinance. Instead of allowing developers to build homes and commercial areas and then providing the sewer, water, and other urban services needed by those areas, Ramapo decided that it would approve new developments only after the capital improvements needed for the development were fully financed.[13]

In 1972, the city of Petaluma, California, took a different approach. Instead of conditioning growth on urban finances, the city simply decided to issue no more than 500 residential building permits a year.[14] Soon after, Boulder, Colorado, decided to limit the number of building permits so that it would grow no faster than 2 percent per year. Boulder was also the first city in the United States to pass a tax dedicated to open space preservation, and the city and county of Boulder have since purchased a greenbelt around the city that is several times the land area of the city itself.[15]

In 1974, San Jose and Santa Clara County (of which San Jose is the seat) drew one of the first urban-growth boundaries outside of which development would be prohibited or restricted. Other places have used urban-service boundaries that limit the extension of sewer, water, and other services, effectively preventing large-scale developments.

All of these practices—concurrency, growth limits, greenbelts, and growth boundaries—are collectively known as *growth-management planning*. While Petaluma and Boulder have tried to control the *rate* of growth, most growth management focuses instead on controlling the *location and density* of growth. This variation of growth management is sometimes called *smart growth*. Also, as practiced by Petaluma and Boulder, growth management can simply drive growth to other nearby communities. So planners in recent decades have focused on creating regional structures that can manage growth throughout an urbanized area and the rural lands beyond its fringes.

Regional growth-management planning plays a major role in the development of seventeen to nineteen different states plus several urban areas in other states. Growth management has evolved in these states and urban areas in five different ways.

First, 10 states have passed planning laws requiring local and regional planners to coordinate the development of growth-management plans. These states include Hawaii (1961), Vermont (1970), Oregon (1973), Florida (1985), New Jersey (1986), Rhode Island (1988), Washington (1990), Maryland (1992), Tennessee (1998), and Arizona (1998). In Hawaii's case, the state itself writes the plan.

Second, seven states have passed laws authorizing but not requiring cities and counties to write growth-management plans. Usually, these laws are accompanied by incentives that may range from grants to support the development of the plan to limits on the use of state infrastructure funds in communities that have not written a plan. These states include Connecticut (1971), Maine (1988), Georgia (1989), Minnesota (1997), New Hampshire (1999), Pennsylvania (1999), and Wisconsin (2000). Washington's 1990 law is unique in that it is mandatory in the western half of the state and optional in the eastern half.

Third, in California and New England, institutional structures that were not originally designed to be regional governments have evolved into mechanisms for implementing growth-management plans. In 1963, various California urban areas had seen disputes over which city would get to annex developable land. So California required every county (except San Francisco, which has no competing jurisdictions) to form a *local agency formation commission* or LAFCo that would approve such annexations. LAFCos could also veto the incorporation of new cities or special service

**To prevent growth from fleeing to nearby communities, planners have focused on creating regional structures that can manage growth throughout an urbanized area and the rural lands beyond its fringes.**

The metropolitan planning organization for Minneapolis-St. Paul used its power to distribute federal funds to coerce local governments into rezoning reluctant neighborhoods for much higher densities.

districts, thus giving cities control over the rate of development on unincorporated county lands. Each LAFCo consisted of representatives of every city in the county, so by the early 1970s LAFCos morphed into regional governments that attempted to manage growth and limit sprawl.[16]

The six New England states (Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont) have largely given up the county form of government and turned most rural planning over to cities and towns. Connecticut and Rhode Island have no county governments, and Massachusetts has abolished many of its counties. These three states have no "unincorporated areas"—every acre in the state is under the jurisdiction of a city or town effectively acting as a regional government. The unincorporated portions of New Hampshire and Vermont are very small, housing just a few hundred people. Maine still has extensive unincorporated areas, but most residents live in an incorporated city or town.[17]

Fourth, in states that have not passed growth-management laws, the federally mandated metropolitan planning organizations have sometimes morphed into true regional governments. To write an enforceable regional plan, MPOs need the approval of a majority of their members and the willingness on the part of that majority to use the MPO's power to distribute federal funds to coerce reluctant local governments into cooperating with the plan.

For example, in 1999 the chair of the Minneapolis–St. Paul MPO, Ted Mondale (son of the former vice president), began promoting an aggressive growth-management agenda that called for a strict urban-service boundary and increased suburban densities instead of further development at the urban fringe. "If we're giving money to communities that are thumbing their noses" at the MPO's plan, asked Mondale, "then what's it all about? It's a charade!"[18] Despite "spirited community opposition," the MPO successfully pressured various suburbs to rezone areas for much higher densities.[19] The Denver Regional Council of Governments adopted a similar plan in 1997.[20]

Lastly, in some cases cities and counties have jointly developed urban-growth boundaries and other growth-management tools that do not necessarily extend to the entire metropolitan area. Five years before Washington passed its growth-management act, King County (Seattle) adopted an urban-growth boundary in support of a plan that emphasized high-density infill and discouraged auto-oriented low-density housing.[21]

In contrast with the above states, most states in the South (except Florida, Georgia, and Tennessee), the Midwest (except Minnesota and Wisconsin), and the interior West (except Arizona, northwest Colorado, and Salt Lake City) have done little to promote regional growth management. That makes it possible to compare the effects of planning on states and regions with and without such plans.

## Housing Affordability

The question of whether growth management reduces housing affordability is hotly debated by planners and economists.[22] As Virginia Tech urban planning professor Robert Lang notes, "growth management schemes exist that can be neutral" with regard to housing. "But in practice, growth management generally affects housing prices."[23]

In freely functioning markets without entry barriers, the price of existing housing cannot rise significantly above the cost of new construction because, if it did, developers would enter the market and build new housing until the price of existing housing was at least equal to and probably below the price of new housing. In what is perhaps the most comprehensive study to date, Harvard economist Edward Glaeser and Wharton economist Joseph Gyourko compared a database of local land-use regulations with the average cost of owner-occupied housing (as a proxy for the marginal cost of new home construction). They found that, in some parts of the country, the prices of existing homes are not significantly different from the nominal cost of new construction, while in other regions existing-home price are well above the costs of new construction.

Glaeser and Gyourko used several economic tests to show that these differences in prices were not due to a stronger demand for existing housing in high-priced areas. Instead, they concluded, "Government regulation is responsible for high housing costs where they exist."[24] However, they did not specifically define what sorts of regulation was responsible for those high prices. Instead, they merely attributed it to "zoning."

In another paper, Gyourko and two colleagues showed that limits on new home construction in growing regions lead wealthy people to outbid the poor for the regions' stock of housing. The result is that the poor are pushed out, creating "superstar cities" composed mainly of wealthy people.[25] These cities regard themselves as successful and (ironically) progressive, when in fact their policies are highly regressive.

For example, the San Francisco–Oakland and Dallas–Ft. Worth metro areas each have about the same number of families with incomes greater than $100,000 per year. But Dallas–Ft. Worth's affordable housing market welcomes two-thirds more families with incomes of $50,000 to $100,000 and twice as many families with incomes under $50,000 per year. Dallas–Ft. Worth's income distribution is much closer to that of the U.S. as a whole than San Francisco–Oakland's.[26] This makes San Francisco–Oakland appear to be a superstar region, when in fact—thanks to restrictive land-use rules—it is just an elitist region. As urban writer Joel Kotkin observes, it is "an oddity" that "the fashionable 'left' defines successful urbanism by its ability to lure the superaffluent" while it pushes out the poor.[27]

More than 80 percent of American homes are in areas that are municipally zoned, but only about 40 percent of America's housing is in unaffordable markets. Some forms of zoning seem to make housing unaffordable, while others do not. A close comparison of affordable and unaffordable housing markets makes it clear that the difference is growth-management planning.

Euclidean zoning—zoning that seeks only to prevent nuisances from disrupting neighborhoods in developed areas—seems to be compatible with affordable housing. Growth-management planning—planning and zoning that seeks to promote the general welfare by controlling the development of all urban and rural land within a state or region—makes housing unaffordable by limiting the amount of vacant land that is readily accessible for new housing.

Looking at Florida's growth-management law, Jerry Anthony, an assistant professor of urban planning at the University of Iowa, found "a statistically significant increase in the price of single-family houses attributable to statewide growth management." Though Anthony supports growth-management planning, he warns, "housing prices could become the Achilles heel of growth management programs and thwart their implementation."[28]

The basic argument of this paper is that

1. By restricting the amount of land available for new housing, the number of permits issued each year, the cost of permits, and/or the amount of time required to obtain permits, growth-management planning constrains the supply of new homes.
2. Because the demand for new housing is *inelastic*, small constraints on the supply of new homes lead to large increases in the price of those homes.[29]
3. Sellers of existing homes respond to increases in the price of new homes by increasing the prices they ask for their homes. Thus, small restrictions on the supply of new homes can lead to large increases in the price of *all* homes in a market.

As Glaeser and Gyourko found, the median value of homes in a market is a good indication of any constraints on the supply of new homes. In wealthier communities, homes are likely to be larger or of higher quality. To account for this, a standard measure of housing affordability is median home price divided

**Growth-management planning creates what appear to be "superstar cities" by making housing so unaffordable that only the wealthy can afford to live there and the poor are pushed out.**

**Table 1**
**Median Home Price to Median Family Income Ratios, and Population Growth**

| State | Price-to-Income | Growth from 2000 to 2006 | State | Price-to-Income | Growth from 2000 to 2006 |
|---|---|---|---|---|---|
| Hawaii | 8.7 | 6.1% | Pennsylvania | 2.7 | 1.3% |
| California | 8.3 | 7.2% | Wyoming | 2.7 | 4.2% |
| District of Columbia | 7.3 | 1.8% | Wisconsin | 2.7 | 3.4% |
| Nevada | 5.0 | 23.6% | Georgia | 2.5 | 13.8% |
| New York | 4.9 | 1.6% | North Carolina | 2.5 | 9.6% |
| Massachusetts | 4.8 | 1.2% | Louisiana | 2.4 | -4.1% |
| Rhode Island | 4.7 | 1.6% | Tennessee | 2.4 | 5.9% |
| Washington | 4.6 | 8.2% | Iowa | 2.4 | 1.8% |
| New Jersey | 4.5 | 3.4% | Michigan | 2.4 | 1.4% |
| Oregon | 4.4 | 7.8% | South Carolina | 2.3 | 7.4% |
| Arizona | 4.4 | 19.3% | Missouri | 2.3 | 4.2% |
| Maryland | 4.3 | 5.7% | Illinois | 2.2 | 3.1% |
| Idaho | 4.2 | 12.8% | Mississippi | 2.2 | 2.2% |
| Florida | 4.2 | 12.7% | Ohio | 2.2 | 1.0% |
| Virginia | 3.8 | 7.6% | Kentucky | 2.2 | 3.9% |
| Connecticut | 3.7 | 2.7% | Arkansas | 2.1 | 4.9% |
| Colorado | 3.7 | 9.8% | Alabama | 2.1 | 3.3% |
| New Hampshire | 3.6 | 6.0% | West Virginia | 2.0 | 0.6% |
| Utah | 3.6 | 13.7% | South Dakota | 2.0 | 3.5% |
| Delaware | 3.5 | 8.5% | Texas | 2.0 | 12.2% |
| Montana | 3.4 | 4.5% | Oklahoma | 1.9 | 3.6% |
| Vermont | 3.4 | 2.3% | Nebraska | 1.9 | 3.2% |
| New Mexico | 3.3 | 7.3% | Kansas | 1.9 | 2.6% |
| Maine | 3.2 | 3.5% | North Dakota | 1.8 | -0.8% |
| Alaska | 3.1 | 6.8% | Indiana | 1.8 | 3.6% |
| Minnesota | 3.1 | 4.7% | | | |

Source: Census Bureau, Office of Federal Housing Enterprise Oversight, and Department of Housing and Urban Development; see notes in text for specific tables and sources.

by median family income, or price-to-income ratio. This price-to-income ratio can be used to detect possible constraints on the supply of new homes.

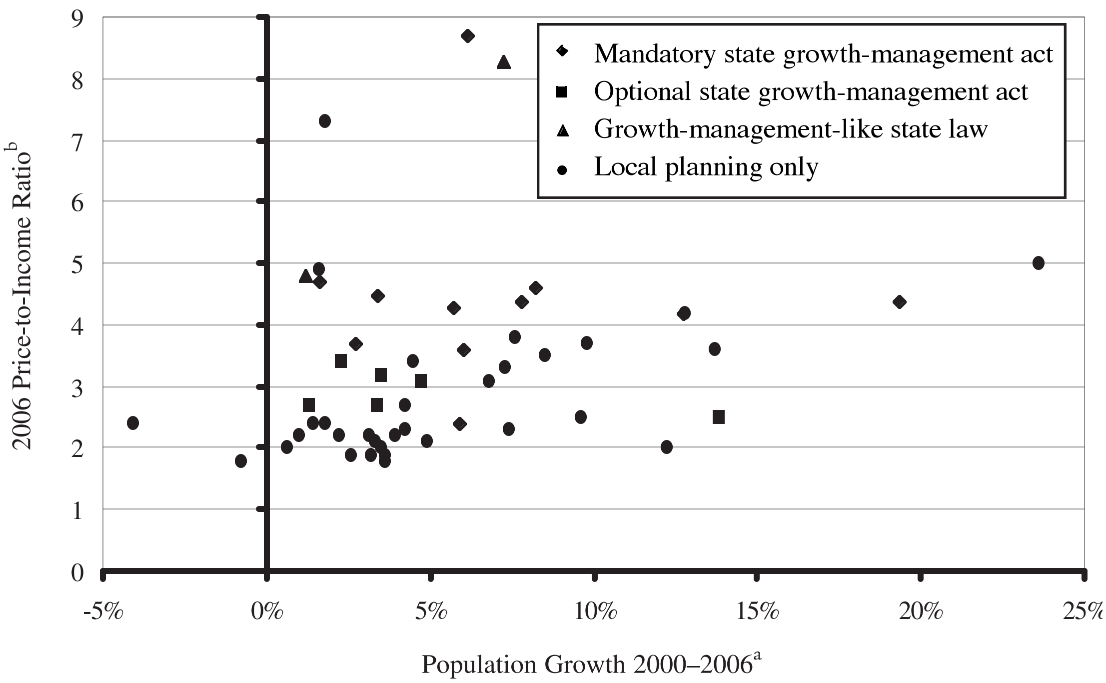
Price-to-income ratios determine how long it would take for a family to pay off a home under standard lending rules. At a 6 percent interest rate and a ratio of 3, for example, a family making a 10 percent down payment and devoting 31 percent of its income to its mortgage could pay off the remaining cost of its home in 15 years. At a price-to-income ratio of 5 it would take nearly 60 years, which—since most mortgages are for no more than 30 years—makes housing unaffordable.

**None of the 18 states with the most affordable housing have passed growth-management laws.**

The Census Bureau has estimated median home values and median family incomes in each decennial census (for the year before each census) since at least 1960.[30] Since the last decennial census, the Department of Housing and Urban Development has annually updated estimates of median family incomes by metropolitan area.[31] The Department of Commerce's Office of Federal Housing Enterprise Oversight publishes a quarterly index of home prices by metropolitan area that can be used to update median home values.[32]

Table 1, showing 2006 price-to-income ratios by state, reveals that all of the states with growth-management laws have price-to-in-

**Figure 1**
**Price-to-Income Ratios vs. Growth**




[a] Data from Census Bureau, "2006 Community Survey," Table C19101 for metropolitan statistical areas, tinyurl.com/ufd9.

[b] Based on Office of Policy Development and Research, Department of Housing and Urban Development, "FY 2006 Income Limits," tinyurl.com/3dsd5w.

Note: Housing price data from Table H8 from the 200 census, adjusted using the home price index, Office of Federal Housing Enterprise Oversight, tinyurl.com/2nhr7z.

come ratios of 3 or more except Georgia, Tennessee, and Wisconsin. The laws in Georgia and Wisconsin are optional, and housing in those states is becoming unaffordable in selected urban areas, notably Savannah, Madison, and Milwaukee. Minnesota's law is also optional, and housing there is unaffordable only in the Twin Cities region. Tennessee's 1998 law may be too new to have yet influenced housing prices.

Contrary to claims by some that high housing prices are solely a function of demand, there is little correlation between growth rates and price-to-income ratios: Texas and Georgia are two of the fastest growing states in the United States, yet they remain very affordable (see Figure 1).

Georgia and Texas show that homebuilders can readily meet just about any demand for housing without driving up prices, provided they can find land for development. Between 2000 and 2006, the Atlanta, Dallas–Ft. Worth, and Houston metropolitan areas each grew by more than 130,000 people—approximately the population of Alexandria, Virginia, or Bridgeport, Connecticut—*per year*. At the same time, low interest rates and easy lending contributed to the most rapid growth in housing prices ever seen in this country. Yet by 2006 Atlanta's price-to-income ratio remained an affordable 2.75, while Houston's and Dallas–Ft. Worth's were very affordable at 2.00 to 2.06.

There is a strong correlation between the passage of growth-management laws or plans and declining housing affordability. Table 2 shows the date when price-to-income ratios first increased above 3.0 in various states and

**Georgia and Texas show that home builders can meet just about any demand for housing without driving up prices, provided they can find land for development.**

**Table 2**
**Growth-Management Laws and Plans and Unaffordable Housing**

| State or Region | Law or Plan | Year P:I>3 |
|---|---|---|
| Hawaii | 1961 law | 1969 |
| California | 1963 law | 1979 |
| Boulder | 1972 plan | 1979 |
| Oregon | 1973 law | 1979 |
| NYC area | NJ & CT laws | 1979 |
| DC area | MD laws and VA plans | 1989 |
| CT, MA, RI, NH | NE town governments | 1989 |
| Seattle/King County | 1985 plan | 1989 |
| Western Washington | 1990 law | 1999 |
| Missoula | 1992 plan | 1999 |
| Denver | 1997 plan | 1999 |
| Florida | 1985 law | 2006 |
| Vermont | 1988 law | 2006 |
| Portland, ME | 1989 optional law | 2006 |
| Twin Cities | 1997 optional law | 2006 |
| Baltimore, Hagerstown | 1997 optional law | 2006 |
| Arizona | 1998 law | 2006 |
| Madison, Milwaukee | 2000 optional law | 2006 |
| New Hampshire | 2000 law | 2006 |
| Nevada | Federal land sales slow | 2006 |

Source: Jerry Anthony, "Do State Growth Management Regulations Reduce Sprawl?" *Urban Affairs Review* 39, no. 3 (2004): 376–97. The year P:I>3 is based on the data in Randal O'Toole, *The Planning Penalty: How Smart Growth Makes Housing Unaffordable* (Bandon, OR: American Dream Coalition, 2006), tinyurl.com/yqzpyn and the 2006 data cited in that paper.

**In most cases, housing price to family income ratios exceed 3.0 soon after passage of growth-management laws or plans.**

metropolitan areas. In most cases, declining housing affordability was preceded by passage of growth-management laws (which were optional in Maine, Maryland, Minnesota, and Wisconsin) or plans.[33]

New York state has no regional planning law, and most of its communities outside the New York City region are affordable. But the city is hemmed in by New Jersey to the south and Connecticut to the northeast, which have some of the strictest planning laws in the nation. Suburbs to the west such as Ramapo pioneered growth-management planning in 1970. In addition, regulation in the city itself tends to limit further construction of homes and apartments. That leaves the New York City urban area with little room to grow. Washington, D.C., is similarly limited by Maryland's planning laws on the north. While Virginia's state laws are less strict, many local governments in Washington's Virginia suburbs have imposed building moratoria and growth boundaries in the form of large-lot zoning of rural areas.[34]

Nevada is the exception that tests the rule that declines in affordability are preceded by approval of growth-management plans. Nevada went from being reasonably affordable in 1989 and 1999 to dramatically unaffordable in 2006. Las Vegas and Reno are two of the fastest-growing urban areas in the nation. In a state where nearly 90 percent of the land is federally owned, this growth has relied on sales of federal land to developers. Those sales slowed after 2000, which led to a rapid rise in land and housing prices.[35]

Extensive government ownership of land has created land shortages and made housing unaffordable in a few other communities, such as Jackson, Wyoming; Aspen, Colorado; and Sun Valley, Idaho. But most expensive housing markets in the U.S. have plenty of private land that is physically suitable for development; it has just been closed to development by urban-growth boundaries or other government restrictions.

These examples show that the key to housing affordability is the existence of relatively unregulated private land in unincorporated areas near to the cities. Thanks to various state growth-management laws, little or no such land can be found in Florida, Hawaii, Maryland, Oregon, or most of Washington. Thanks to LAFCos, most unincorporated land in California is off limits to development. Thanks to New England's unusual forms of local government, little or no unincorporated land is available in those states. Thanks to regional growth-management plans, such land is scarce in Denver, Ft. Collins, Madison, Milwaukee, Missoula, Seattle, and the Twin Cities. Thanks to extensive federal ownership, there is also a shortage of such land in Nevada and a few other places.

If easily developable vacant land is available outside of incorporated cities, those cities will act competitively to minimize their planning obstacles and invite developers within their boundaries. That, in turn, will keep housing affordable. If, through LAFCos, regional governments, New England town governments, or other means, cities can gain control of development rates in the rural areas, then they will have far less of an incentive to make development easy within their borders. By limiting competition between municipalities, regional growth-management planning creates land and housing shortages.

When planning-induced housing shortages make housing unaffordable for most people in a region, planners' typical response is to pass ordinances or laws requiring developers to sell 10 to 20 percent of the homes they build to low-income people at below-market prices.[36] Such inclusionary zoning rules may provide affordable homes for a small number of people. But several economic studies have shown that they further reduce the general level of housing affordability in a city or region. After looking at dozens of California communities, economists Benjamin Powell and Edward Stringham found that, after these communities passed inclusionary zoning rules, the number of homes built fell by an average of 31 percent and homebuilders lost anywhere from $100,000 to more than $1 million for each unit they had to sell below cost. The homebuilders presumably passed most or all of those losses on to the buyers of the remaining homes they built.[37]

## The Cost of Regional Planning

Between 1959 and 1999, price-to-income ratios in the United States averaged between 2.0 and 2.5. In 1999, they were 2.23. The recent housing boom pushed the average ratio to 3.4. In metropolitan areas—heavily weighted with areas having growth-management planning—it averaged 3.8, while in rural areas it averaged only 3.0.

It therefore seems likely that, in the absence of growth-management planning, price-to-income ratios in most of the nation would still be less than 3.0 today, the only exceptions being places with genuine shortages of land. When price-to-income ratios are inflated because of regional planning, the difference between actual housing costs and what they would be without planning is, in effect, a planning tax imposed on homebuyers. This tax can be conservatively calculated by comparing actual median home values with what home prices would be if price-to-income ratios were 3.0. This is conservative because price-to-income ratios would probably be less than 3.0 in many regions were it not for growth-management planning.

Table 3 shows the planning tax per median house in selected states and metropolitan areas. In a few areas, the tax is under $10,000, but in many more it is above $100,000. In dif-

**In the absence of growth-management planning, price-to-income ratios would be less than 3.0. In places with such planning, when prices exceed this ratio, the added cost can be considered a planning tax imposed on homebuyers.**

**Table 3**
**The Cost of Growth-Management Planning**

| | Planning Tax Per Median Home | Tax on All 2006 Sales (millions) | | Planning Tax Per Median Home | Tax on All 2006 Sales (millions) |
|---|---|---|---|---|---|
| **States with Growth Management** | | | | | |
| Arizona | 77,400 | 6,860 | Maryland | 100,440 | 7,826 |
| Flagstaff | 109,030 | 150 | Baltimore | 77,588 | 2,657 |
| Phoenix | 92,144 | 4,561 | Bethesda-Frederick | 194,173 | 2,922 |
| Tucson | 53,217 | 648 | Massachusetts | 132,647 | 11,088 |
| California | 337,905 | 126,674 | Boston | 215,416 | 4,392 |
| Fresno | 143,553 | 1,135 | Cambridge | 173,273 | 3,077 |
| Los Angeles | 378,443 | 29,118 | Springfield | 35,086 | 295 |
| Oakland | 450,021 | 12,520 | New Hampshire | 43,445 | 893 |
| Sacramento | 202,940 | 4,844 | Manchester | 25,974 | 131 |
| San Diego | 355,565 | 10,612 | New Jersey | 122,145 | 13,920 |
| San Francisco | 718,264 | 12,369 | Atlantic City | 95,857 | 330 |
| San Jose | 612,881 | 11,279 | Trenton | 47,554 | 210 |
| Connecticut | 59,484 | 2,846 | Newark | 161,110 | 3,904 |
| Hartford | 13,061 | 200 | Oregon | 84,686 | 4,316 |
| New Haven | 70,266 | 723 | Eugene | 68,327 | 295 |
| Florida | 65,324 | 19,533 | Portland | 93,737 | 2,427 |
| Fort Lauderdale | 110,070 | 2,689 | Rhode Island | 109,475 | 1,477 |
| Jacksonville | 15,685 | 275 | Providence | 107,560 | 2,051 |
| Miami | 150,355 | 3,777 | Vermont | 25,201 | 275 |
| Naples | 247,149 | 1,248 | Burlington | 39,202 | 109 |
| Orlando | 61,503 | 1,593 | Washington | 100,237 | 8,738 |
| Hawaii | 382,589 | 5,406 | Seattle | 179,776 | 5,701 |
| Honolulu | 394,146 | 3,242 | Spokane | 22,800 | 134 |
| | | | Tacoma | 94,830 | 876 |
| **Other Urban Areas with Growth Management Plans** | | | | | |
| Boulder | 101,023 | 413 | Minneapolis-St. Paul | 14,848 | 685 |
| Denver | 38,796 | 1,264 | Missoula | 70,900 | 93 |
| Ft. Collins | 37,698 | 147 | Madison, WI | 9,578 | 67 |
| Portland, ME | 56,300 | 415 | Milwaukee | 7,551 | 143 |

Source: Author's caluculations.
Note: The planning tax is a conservative estimate of the additional amount buyers of median-priced homes must pay because of growth-management planning. The total tax is a conservative estimate of the total additional amounts paid by homebuyers for houses purchased in 2006. A spreadsheet presenting calculations and results for every state and metropolitan area can be downloaded from tinyurl.com/3bevle.

**The cost of growth-management planning is often more than $100,000 per home.**

ferent parts of the San Francisco Bay Area, it ranges from $450,000 to more than $700,000. This is a huge burden to impose on homebuyers.

The insidious nature of growth management is that, by placing restrictions on new home construction, it affects the prices of all homes in a region. For example, one source of the planning tax is impact fees that are intended to cover the capital costs of infrastructure such as roads, sewer, water, and schools. These fees are applied only to new homes but, because sellers of existing homes base the prices they ask on the cost of new homes, the fees end up increasing the cost of all housing in a region. If the goal is to recover the capital cost that new low-density homes impose on urban service providers, the best solution is a service district, limited improvement district, or other financial program that allows developers or local governments to sell bonds that would repaid by new homeowners and other property owners over a 20- to 30-year period. Monthly or annual payments, instead of a single up-front impact fee, would insure that growth pays for itself without influencing the general level of housing affordability.

Table 3 also presents estimates of the total planning tax paid by homebuyers in 2006. In the vast majority of cases, this planning tax is far more than the $11,000 that *The Costs of Sprawl—2000* estimates low-density housing imposes on urban-service providers. Moreover, the planning tax applies to every owner-occupied home in a region, not just to new homes. The estimate of the total planning tax conservatively assumes that 5 percent of a region's housing stock is sold each year. In fact, in 2006, 5.9 percent of homes in the nation were sold.[38] Note, too, that the total tax numbers apply only to owner-occupied homes; if the planning tax were also calculated for rental housing and non-residential properties, the total tax would be signifiantly more.

Nationally, the total planning-tax paid by homebuyers in 2006 was close to $250 billion. About half of this was in California. Most of the rest was in nine states with statewide growth-management laws: Arizona, Florida, Hawaii, Maryland, New Jersey, Oregon, Rhode Island, Vermont, and Washington. The remainder was in New England, New York City, and Washington, D.C., and in a number of other urban areas that have adopted regional growth-management plans with or without state growth-management laws.

The planning tax imposed on homebuyers is partly offset by windfall profits for sellers of existing homes. But existing homeowners who want to trade up to a larger or better home face the same obstacles as first-time homebuyers: thanks to regional planning, the new home they want to buy also costs much more than it should. Sellers of new homes, of course, do not earn windfall profits, because it is the increase in their costs that makes housing unaffordable. The existence of windfall profits also raises an equity issue, as homesellers tend to be wealthier than homebuyers.

In effect, growth-management planning can be interpreted as a cartel of existing homeowners who limit the supply of new homes in order to drive up the value of their own homes. This has been called the *homevoter hypothesis*.[39] While homevoting may be important in maintaining political support for growth management, in a previous paper this writer argued that it is only one of several factors behind growth-management planning.[40] An additional factor is municipal finance: cities object to developments outside their borders because they want to keep new tax revenues for themselves. As this paper has shown, when cities can gain control over development rates in rural areas, they respond by imposing growth-management rules.

**When cities gain control over development rates in rural areas, they respond by imposing growth-management rules aimed at maximizing their tax revenues.**

## Housing Bubbles

Housing bubbles are one of the negative side effects of regional growth-management planning. The most recent bubble is often blamed on low interest rates and easy credit, but in fact housing prices bubbled mainly in regions where there were shortages of land for new housing or other planning-induced housing shortages. As economist Paul Krugman noted in 2005, prices rose most in what he called "the zoned zone," where land-use restrictions make "it hard to build new houses," while in the rest of the country prices rose not much faster than inflation.[41]

At least two economic studies have confirmed a relationship between growth-management planning and housing bubbles. A 2005 economic analysis of the housing market in Great Britain, which has practiced growth management since 1947, found that planning makes housing markets more volatile, that is, more susceptible to booms and busts. "By ignoring the role of supply in determining house prices," the report says, "planners have created a system that has led not only to higher house prices but also to a highly volatile housing market."[42]

A more recent study by Harvard economist Edward Glaeser also finds that land-use rules that restrict "housing supply lead to greater volatility in housing prices." Glaeser found that, "if an area has a $10,000 increase in housing prices during one period, relative to national and regional trends, that area will lose $3,300 in housing value over the next five-year period."[43]

Historically, U.S. housing prices have grown at about the rate of inflation.[44] Planning-induced housing shortages lead to bubbles because housing prices in regions with growth-management planning rise faster than normal. This attracts investors—sometimes derisively termed "speculators"—seeking capital gains. In extreme cases, this leads to well-documented frenzies, as when tiny or poorly built homes sell for unrealistically high prices to "flippers," that is, to people who expect to quickly resell at even higher prices.[45] Eventually the bubble deflates, leading the present situation where homebuilders are forced to cut $100,000 or more from the prices of their homes.[46]

**Planning-induced housing prices lead to bubbles when rising prices attract investors seeking capital gains as well as ordinary homebuyers.**

In the 380 housing markets for which data are available, there is a strong correlation between the price-to-income ratios in 1999 and the increase in housing prices between 1999 and 2006.[47] In Atlanta, Dallas, and Houston, where housing was affordable in 1999, price-to-income ratios grew by only 13 to 24 percent. In California cities where housing was already very unaffordable in 1999, ratios grew by 80 to 140 percent.

The correlation between 1999 affordability and subsequent price increases is less than perfect partly because Florida and other states that had recently implemented growth-management laws still had affordable housing in 1999. But by 2006, it was quite unaffordable: price-to-income ratios in Florida grew by 55 to 150 percent, while ratios in most Georgia housing markets grew by only 20 to 30 percent.

The United States has experienced housing bubbles before. A bubble in the late 1970s saw California and Oregon housing prices peak in 1980, then fall by about 10 to 20 percent (after adjusting for inflation) over the next four years. A bubble in the late 1980s saw prices in California and the Northeast peak in 1990, then fall by 10 to 20 percent in the Northeast and 20 to 30 percent in California over the next six years.[48]

What is significant about the most recent housing bubble is that it affected so many more housing markets than previous bubbles. The biggest bubbles were in California and Florida, where price-to-income ratios typically doubled between 1999 and 2006. But nearly a third of the nation's metropolitan areas, representing nearly 40 percent of the nation's housing, saw price-to-income ratios rise by 50 percent or more. That includes markets in Arizona, California, Florida, Hawaii, Maryland, Oregon, Washington, the New England states, and the New York, Washington, and Philadelphia metropolitan areas.[49]

These bubbles and subsequent collapses are not good for the economy and certainly not good for people buying homes at artificially inflated prices. A significant share of the recent chaos in the lending industry and stock market can be credited to regional growth-management planners.

## Economic Growth

Planning-induced housing shortages affect more sectors of the economy than just housing. Retail, commercial, and industrial developers all need land, and restrictions on the amount of land available for their use will drive up their costs. Businesses in areas with expensive housing may also have to pay their employees more than businesses in other areas to compensate for the higher cost of living. These increased costs of doing business can deter employers from building or expanding in areas with growth-management planning.

There are few more dramatic examples of this than the San Jose urban area, which grew by an average of more than 42,000 people per year between 1950 and 1970. As the heart of the nation's booming high-tech industry, San Jose could have grown much faster than it has in the last three decades, but its growth was inhibited by a growth-management plan approved in 1974. During the 1970s and 1980s it grew by only 20,000 people per year. Growth contracted to 10,000 people per year in the 1990s and less than 8,000 people per year to date since 2000.

The imposition of growth-management plans in coastal California urban areas has pushed growth into California's interior. Since 2000, coastal California metropolitan areas have grown by an average of 3.5 percent, while interior metro areas have grown by an average of 15.5 percent. The data suggest that price-to-income ratios of 4 or more can significantly curtail growth unless that growth is the result of people and jobs fleeing even less affordable regions nearby.

Just as planning-induced land shortages can make housing markets more volatile, they can also make job markets volatile. Glaeser's study of land-use regulation found that "places with rapid price increases over one five-year period are more likely to have income and employment declines over the next five-year period."[50]

## Urban Sprawl

Urban planners say that the most important goal of growth-management planning is to curb urban sprawl. Urban sprawl—the pejorative term for low-density development—reflects the preferences of the vast majority of Americans to live in a single-family home with a yard.[51] The United States has a huge abundance of open space: less than 3 percent of the U.S. is considered urban (which the Census Bureau defines as "densely settled areas with a population of 2,500" or more[52]), and 95 percent of the nation is rural open space. Even New Jersey, the nation's most heavily developed state, is 65 percent rural open space.[53]

So the push for dense housing and hostility to low densities seems perplexing. As Urban Land Institute researcher Douglas Porter notes, there is a "gap between the daily mode of living desired by most Americans and the mode that most city planners . . . believe is most appropriate." While most Americans "want a house on a large lot and three cars in every garage," planners believe this leads to a urban development pattern "that is expensive in terms of public and private infrastructure costs, quality of life, and environmental damage." Porter's 1991 paper urged planners to use regional governments to impose their goals on reluctant voters.[54]

Whether curbing sprawl is a worthwhile goal or not, it is worth asking whether growth-management planning can achieve such a goal. University of Iowa planning professor Jerry Anthony compared changes in urban population densities in 11 states that had passed growth-management laws before 1997 with states that had no similar laws. Recognizing the growth-management efforts of LAFCos, he included California among the states with growth-management laws. Anthony found that "state growth management programs did not have a statistically significant effect in checking sprawl."[55]

In 2001, the Willamette Valley Livability Forum, a supporter of growth-management planning, published a report projecting—with and without such planning—the effects of development on Oregon's Willamette Valley, which covers one-seventh of the state but houses two-thirds of Oregon's people. Based on research by a local economics consulting firm, the report noted that 5.9 percent of the valley was urbanized in 1990. It projected that, under Oregon's strict land-use rules, that would increase to 6.6 percent by 2050. If, however, those rules were eliminated to "let private property rights and short-term market forces" determine land uses, by 2050 the total amount of urbanized land would cover 7.6 percent of the valley.[56] Table 3 shows that, to protect just 1 percent of the Willamette Valley from development, Oregon's land-use rules are costing valley

**In order to protect just 1 percent of Oregon's Willamette Valley from development, the state's land-use rules cost homebuyers $70,000 to $90,000 per home.**

**The key to keeping housing affordable is the availability of relatively unregulated vacant land outside city boundaries.**

(Eugene and Portland) homebuyers $70,000 to $90,000 per median-priced home.

Growth-management planning can profoundly change the character of the cities in which it is practiced. By making housing unaffordable, cities such as San Francisco, Portland, and Seattle have driven families with children to suburbs where they can afford a single-family home with a yard. In 2000, 26 percent of the nation's population was under the age of 18. But only 14.5 percent of San Franciscans, 15.6 percent of Seattleites, and 21.1 percent of Portlanders were under 18.[57] Although Portland's 2000 population was twice what it was in the 1920s, Portland schools educated fewer students in 2000 than in 1925.[58]

The result is that the central cities are inhabited largely by young singles and childless couples. These people may be more willing to live in higher densities and to walk or bicycle than older people or families with children, so planners believe that their plans are working to reduce driving and sprawl. But in fact all they are doing is to separate the population into those who are willing to live in denser areas and to move to the central cities, from those who prefer low densities, who move to the sometimes-distant suburbs.

## Conclusion

As it is usually practiced, regional growth-management planning imposes huge costs on homebuyers, renters, and businesses. Yet it provides negligible benefits: it does little to reduce sprawl (if that can even be considered a benefit), and its greatest social effect is to sort urban areas into central cities largely composed of young singles and childless couples and suburbs with high percentages of families with children.

The key to affordable housing is the availability of relatively unregulated vacant land for housing and other urban purposes. The effects of denying homebuilders access to such developable land appears to be an almost relentless upward push of housing prices. In 1979, price-to-income ratios in coastal California cities were greater than 4. By 1989, they exceeded 5.0. Thanks to a major recession in the early 1990s, they were still between 5 and 6 by 1999, but today they are mostly greater than 8. Prices may be declining now, but—unless changes are made—states such as Arizona, Florida, and Oregon whose price-to-income ratios were 4 or more in 2006 can expect to have California's price-to-income ratios in a decade or two.

Remedies for unaffordable housing will require actions at the federal, state, and local levels.

- The federal government should revoke requirements that all urban areas must be represented by metropolitan planning organizations. Congress should also repeal the comprehensive, long-range planning requirements found in federal transportation and housing legislation.
- States with growth-management laws should repeal those laws and other states should avoid passing similar ones.
- Other state laws that give cities power to control the rate of development of rural areas, such as the California law creating local agency formation commissions, should also be repealed. Instead, states should insure that plenty of vacant land is available to meet each region's need for housing and other land uses.
- Local governments should resist efforts by MPOs and other regional agencies to impose region-wide planning on their urban areas.
- As far as possible, infrastructure should be paid for by developers or property owners through annual user fees and special service districts rather than through up-front impact fees or general taxation.

Urban planners, of course, may oppose these actions. Instead, they aspire to pass growth-management laws in every state and impose growth-management plans on every urban area. The predictable result will be increasingly unaffordable housing, declining homeownership rates, and a growing disparity between the elite who own their own homes and a significant number of families who will never become homeowners.

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Policy Analysis

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# How Urban Planners Caused the Housing Bubble

by Randal O'Toole

## Executive Summary

Everyone agrees that the recent financial crisis started with the deflation of the housing bubble. But what caused the bubble? Answering this question is important both for identifying the best short-term policies and for fixing the credit crisis, as well as for developing long-term policies aimed at preventing another crisis in the future.

Some people blame the Federal Reserve for keeping interest rates low; some blame the Community Reinvestment Act for encouraging lenders to offer loans to marginal homebuyers; others blame Wall Street for failing to properly assess the risks of subprime mortgages. But all of these explanations apply equally nationwide, while a close look reveals that only some communities suffered from housing bubbles.

Between 2000 and the bubble's peak, inflation-adjusted housing prices in California and Florida more than doubled, and since the peak they have fallen by 20 to 30 percent. In contrast, housing prices in Georgia and Texas grew by only about 20 to 25 percent, and they haven't significantly declined.

In other words, California and Florida housing bubbled, but Georgia and Texas housing did not. This is hardly because people don't want to live in Georgia and Texas: since 2000, Atlanta, Dallas–Ft. Worth, and Houston have been the nation's fastest-growing urban areas, each growing by more than 120,000 people per year.

This suggests that local factors, not national policies, were a necessary condition for the housing bubbles where they took place. The most important factor that distinguishes states like California and Florida from states like Georgia and Texas is the amount of regulation imposed on landowners and developers, and in particular a regulatory system known as *growth management*.

In short, restrictive growth management was a necessary condition for the housing bubble. States that use some form of growth management should repeal laws that mandate or allow such planning, and other states and urban areas should avoid passing such laws or implementing such plans; otherwise, the next housing bubble could be even more devastating than this one.

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**As late as the fourth quarter of 2008, home prices remained stable in many parts of the country.**

## Misconceptions about the Housing Bubble

In 2005, both Alan Greenspan and Ben Bernanke argued that there was "no housing bubble" and that people need not fear that such a bubble would burst. Greenspan admitted there was "froth" in local housing markets but no national bubble. Bernanke argued that growing housing prices "largely reflected strong economic fundamentals" such as growth in jobs, incomes, and new household formation.[1]

How could they have gone so wrong? "Bubble deniers point to average prices for the country as a whole, which look worrisome but not totally crazy," Princeton economist Paul Krugman wrote in a 2005 newspaper column. "When it comes to housing, however, the United States is really two countries, Flatland and the Zoned Zone." Flatland, he said, had little land-use regulation and no bubble, while the Zoned Zone was heavily regulated and was "prone to housing bubbles."[2]

Krugman's choice of terms is unfortunate because most of "Flatland" is in fact zoned. What makes the Zoned Zone different is not zoning but *growth-management planning*, a broad term that includes such policies as urban-growth boundaries, greenbelts, annual limits on the number of building permits that can be issued, and a variety of other practices.

*Growth control*, which limits a city's growth to a specific annual rate, is a form of growth-management planning that was popular in the 1970s. *Smart growth*, which discourages rural development and encourages higher-density development of already developed areas, is another form that is more popular today. No matter what the form, by interfering with markets for land and housing, growth-management planning almost inevitably drives up housing prices and is closely associated with housing bubbles.

Harvard professor Harvey Mansfield criticizes economists for failing to foresee the housing bubble.[3] But, in fact, many economists did see the bubble as it was growing and predicted that its collapse would lead to severe hardships.

For example, as early as 2003 *The Economist* observed, "The stock-market bubble has been replaced by a property-price bubble," and pointed out that "sooner or later it will burst."[4] By 2005, it estimated that housing had become "the biggest bubble in history." Because of the effects of the bubble on consumer spending, *The Economist* warned, the inevitable deflation would lead to serious problems. "The whole world economy is at risk," the newspaper pointed out,[5] adding, "It is not going to be pretty."[6] Although *The Economist* did not predict the complete collapse of credit markets, it was correct that the bubble's deflation was not pretty.

After home-price deflation led to the credit crisis, it became "conventional wisdom that Alan Greenspan's Federal Reserve was responsible for the housing crisis," notes Hoover Institution economist David Henderson in a column in the *Wall Street Journal*.[7] Although Henderson disagreed with this view, several other economists writing in the same issue agree that by boosting demand for housing, the Federal Reserve Bank's low interest rates caused the housing bubble. "The Fed owns this crisis," charges Judy Shelton, the author of *Money Meltdown*.[8]

Other people blame the crisis on the Community Reinvestment Act and other federal efforts to extend homeownership to low-income families.[9] Those policies, along with unscrupulous lenders, fraudulent homebuyers, and greedy homebuilders—all of whom have also been blamed for the housing crisis—have two things in common. First, they focus on changes in the demand for housing. Second, they are all nationwide phenomena.

National changes in demand should have had about the same effect on home prices in Houston as in Los Angeles. But they did not. As this paper will show, just as prices rose much more dramatically in Krugman's Zoned Zone than in Flatland, prices later fell steeply in most of the Zoned Zone but—except for states where home prices declined because of the collapse of the auto industry—prices hardly fell at all in Flatland. As late as the fourth quarter of 2008, home prices remained stable in many non-bubbling parts of the country. This suggests that the real source of the bubble was limits on supply that exist in some parts of the country but not in others.

In response to the crisis, some have suggested that the federal government should buy surplus homes and tear them down or rent them to low-income families. This misreads the crisis, which is not due to a surplus of homes but to an artificial shortage created by land-use regulation. This shortage pushed up home prices to unsustainable levels, but that doesn't mean that there is no demand for housing at more reasonable prices.

Related to this are increased claims that this crisis signals the last hurrah for suburban single-family homes. "The American suburb as we know it is dying," proclaims *Time* magazine.[10] The *Atlantic Monthly* frets that suburbs will become "the next slums." Both articles quote a demographic study that claims that "by 2025 there will be a surplus of 22 million large-lot homes (on one-sixth of an acre or more) in the U.S."[11] Ironically, articles such as these promote an intensification of the kind of land-use regulation that created the housing bubbles.

## A Theory of the Housing Bubble

Bubbles have characterized recent economic history, as institutional and other major investors have sought high-return, low-risk investments. These investments have turned into speculative manias that eventually come crashing down. The last decade alone has seen the telecom bubble, the nearly simultaneous dot-com bubble, the housing bubble, and most recently, the oil bubble—all of which led the satirical newspaper, *The Onion*, to report, "Nation Demands New Bubble to Invest In."[12]

Of these, the housing bubble is the most significant. On one hand, consumer spending fed by people borrowing against the temporarily increased equity in their homes kept the world economy going after the high-tech and telecom bubbles burst in 2001. On the other hand, the eventual deflation of the housing bubble caused far more severe economic problems than the deflation of the telecom and high-tech bubbles would have caused if the housing bubble had not disguised them.

A *bubble* has been defined as "trade in high volumes at prices that are considerably at variance with intrinsic values."[13] Bubbles are essentially irrational, so they are difficult to describe with a rational economic model. However, the preliminaries to the housing bubble can be explained using simple supply-and-demand curves.

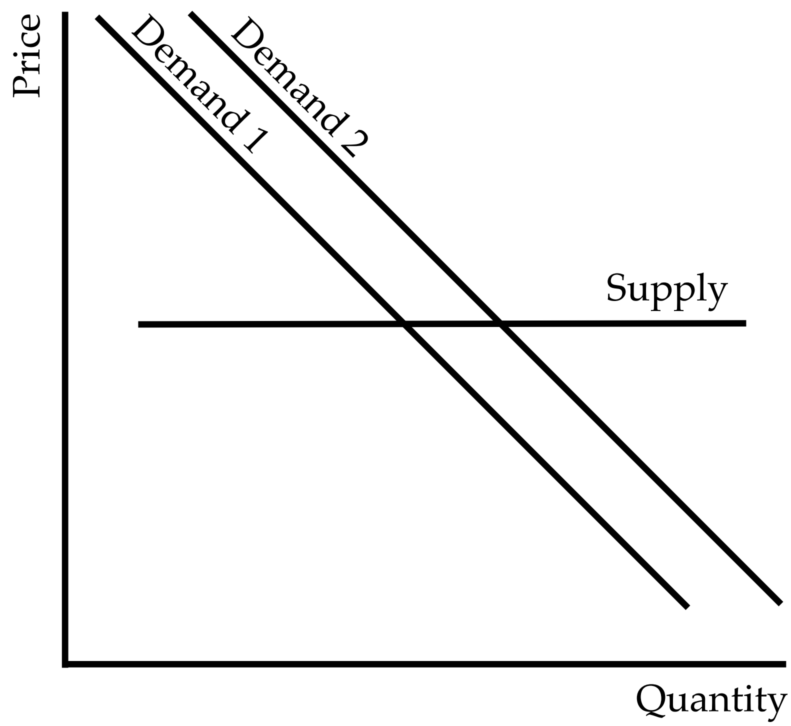
Charles Kindleberger's classic book *Manias, Panics, and Crashes* describes six stages of a typical bubble. First, a *displacement* or outside shock to the economy leads to a change in the value of some good. Second, new *credit instruments* are developed to allow investors to take advantage of that change. This leads to the third stage, a period of *euphoria*, in which investors come to believe that prices will never fall. This often results in a period of *fraud*, the fourth stage, in which increasing numbers of people try to take advantage of apparently ever-rising prices. Soon, however, prices do fall, and, in the fifth stage, the market *crashes*. In the sixth and final stage, government officials try to impose new regulation to prevent such bubbles from taking place in the future.[14] All of these stages are apparent in the recent housing bubble. The key point of this paper is that because growth controls did not allow heightened demand for housing to dissipate through new supply, the result was an immense price bubble in states housing nearly half of the nation's population.

Housing markets include both new and used housing. New housing accommodates population growth and replaces both worn-out older housing and housing in areas that are being converted to other uses. The price of used housing is set by the cost of new housing. If the price of new housing rises, sellers of existing homes will respond by adjusting their asking prices. Thus, to understand the price of housing, we must focus on the supply and demand curves for new housing.

The steepness of those curves—which economists call *elasticity*—describes the sensitivity of prices to changes in demand or supply. A flat or elastic supply curve, for example,

**Claims that the suburbs are dying are made to support the policies that created the housing bubbles in the first place.**

**Figure 1**
**Elastic Housing Supply**




Note: When supply is perfectly elastic, changes in demand have no influence on price.

The 2000 census found that urban areas housing 79 percent of the nation's people occupy less than 2.5 percent of the nation's land.

means that large changes in demand will lead to only small changes in price. But a steep or inelastic curve means small changes in demand can lead to large changes in price.

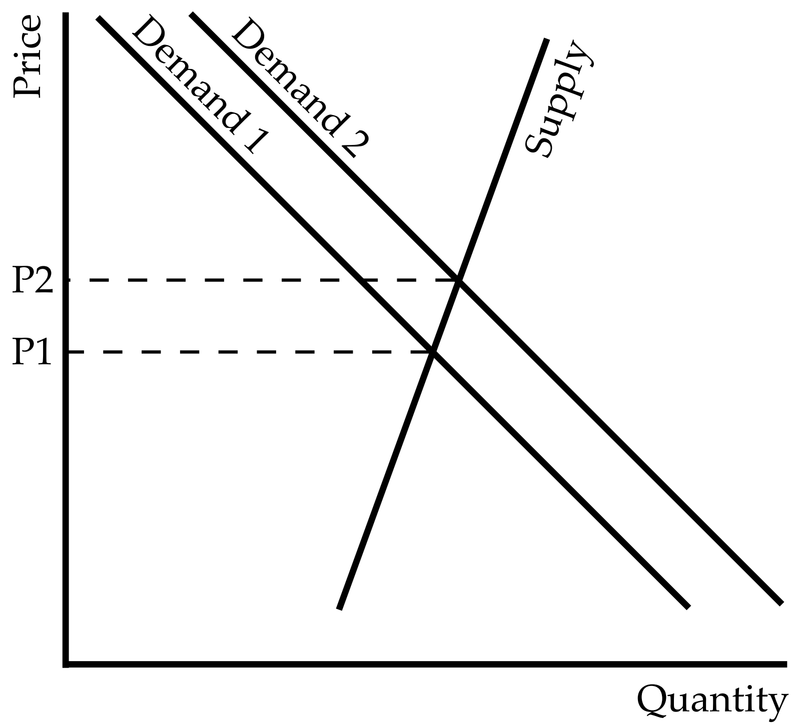
The demand for housing is inelastic: few Americans are willing to live without a home.[15] The vast majority of Americans, moreover, prefer a single-family home with a yard.[16] The same is true for Canadians and, likely, the people of most other nations.[17] While people are willing to live in multifamily housing, most see such housing as only temporary until they can afford a single-family home. This suggests that the demand for single-family housing may be even more inelastic than for housing in general. Inelastic demand curves mean that a small change in the supply of new homes can lead to large changes in price.

While demand for housing is inelastic, supply can be either elastic or inelastic. The main determinants of the cost of new housing are land, materials, labor, and the time required to construct a house. Although realtors love to remind people that the supply of land is fixed, it is actually fixed at an extremely abundant level.

The 2000 census found that U.S. urban areas of more than 2,500 people house 79 percent of the population, yet they occupy less than 2.5 percent of the nation's land.[18] This means that, with rare exceptions, the value of land for housing at the urban fringe is influenced mainly by its value for other purposes, such as farming. Given that farmland is also abundant—the U.S. has nearly 800 million acres of private agricultural land, but farmers grow crops on less than 400 million of those acres—those alternate values tend to be low.[19]

Land can also be valuable for its proximity to certain activities such as jobs, schools, retail, and amenities such as parks. But the automo-

**Figure 2**
**Inelastic Housing Supply**




Note: When both supply and demand are inelastic, small changes in either result in large changes in price.

bile has greatly reduced the relative importance of such "agglomerative economies." Jobs, housing, retail, and other activities are distributed through modern urban areas in a fine-grained pattern. For example, downtowns typically have only about 10 percent of the jobs in their urban areas, and suburban and other job centers typically have only 20 to 30 percent of the jobs.[20] This means that 60 to 70 percent of the jobs are finely distributed throughout the area.

As a result, the *monocentric* view of a city, in which people pay a premium to locate near the downtown area and housing prices steadily decline with distance from downtown, is obsolete. Under this view, housing is expensive in some urban areas because people are not willing to live far from the center, and so they drive up housing prices to live closer. In fact, few or no U.S. urban areas look like this. Instead, housing prices vary more according to the quality of schools, proximity to parks or other amenities, and similar factors, meaning that there is no predictable rent gradient in any cross section of the region.

Thanks to low transportation costs, construction supplies cost about the same throughout the United States. Labor costs vary somewhat, but one of the reasons for such variation is the difference in housing costs.

The last key factor in housing prices is time—specifically, the actual time it takes to construct a home and the time it takes to get permits for construction. Thanks to assembly-line methods developed during and after World War II, homes can be built in a few months. However, permit times vary anywhere from zero (in a few Nevada counties that don't even require building permits) to many years, and—in the case of some large projects—decades.

**Downtowns today typically have only about 10 percent of a region's jobs.**

**Houston's minimal government regulation allows homebuilders to provide for 125,000 new residents a year while keeping the price of a 2,200-square-foot home well under $200,000.**

## A Normal Housing Market

In a recent attempt to prop up sales, the National Association of Realtors produced a television ad claiming that "on average, home values nearly double every 10 years," which is a growth rate of about 7 percent per year.[21] This is true only when areas with restrictive land-use regulations are included in the average.

Prior to 1970, median home prices in the vast majority of the United States were 1.5 to 2.5 times median family incomes.[22] The main exception was Hawaii, which, not coincidentally, had passed the nation's first growth-management law in 1961.[23] Home-value to income ratios remain in that range today in most places that do not have growth-management planning. In other words, in the absence of government regulation, median housing prices average about two times median family incomes.

Without supply restrictions, housing prices grow only if median family incomes grow. Even then, most of the growth in median housing prices is due to people building larger or higher-quality homes, thus increasing the value of the median home. The actual value of any given home will not grow much faster than inflation.

In a normal housing market, then, home values keep up with inflation and median home values keep up with median family incomes. Markets become abnormal when there is some limit on the supply of new homes—and most such limits result from government regulation. The National Association of Realtors' claim may be correct when regulated housing markets are averaged with unregulated ones, but it is incorrect if it is applied to unregulated markets alone.

## The Extremes: Houston vs. San Francisco

Houston is an example of a place where, with minimal government regulation, the supply curve for housing is almost perfectly elastic. Houston and surrounding areas have no zoning, so developers face minimal regulation when building on vacant land. Once built, most developers add deed restrictions to their properties in order to enhance their value for buyers who want assurance that the neighborhood will maintain a positive character. But these deed restrictions do not impede further growth, as there is plenty of land in the region without such restrictions.[24]

In the suburbs of Houston, developers often assemble parcels of 5,000 to 10,000 acres, subdivide them into lots for houses, apartments, shops, offices, schools, parks, and other uses, and then sell the lots to builders. The developers provide the roads, water, sewer, and other infrastructure using *municipal utility districts*, which allow homebuyers to repay their share of the costs over 30 years. At any given moment, hundreds of thousands of home sites might be available, allowing builders to quickly respond to changing demand by building both on speculation and for custom buyers.

Between 2000 and 2008, the Houston metropolitan area grew by nearly 125,000 people per year. This is 10 times faster than population growth in 85 percent of American metropolitan areas.[25] Yet brand-new homes are available in Houston-area developments for less than $120,000, and four-bedroom, two-and-a-half bath homes on a quarter-acre lot average under $160,000.[26] When supply is this elastic, the inelasticity of demand is irrelevant.

In contrast, land-use regulations steepen the supply curve, making supply as well as demand inelastic. While the exact nature of such regulations varies from state to state, typically they involve the use of urban-growth boundaries outside of which development is limited to homes on lots as large as 80 acres; a lengthy and uncertain permitting process; high impact fees; and frequent passage of new regulations that make subdivision and construction increasingly costly and difficult.

The eight counties in the San Francisco Bay Area, for example, have collectively drawn urban-growth boundaries that exclude 63 percent of the region from development. Regional and local park districts have purchased more than half of the land inside the boundaries for open space purposes. Virtually all of the remaining 17 percent has been urbanized, making it nearly impossible for developers to assemble more than a few small parcels of land for new housing or other purposes.[27]

Urban-growth boundaries and greenbelts not only drive up the cost of new homes, they make each additional new housing unit more expensive than the last. In other words, they steepen the supply curve.

Once growth boundaries are in place, cities no longer need to fear that developers will simply build somewhere else. This gives the cities carte blanche to pass increasingly restrictive rules on new construction. In places like Houston, such rules would drive developers to unregulated land in the suburbs. In the San Francisco Bay Area, the nearest relatively (with emphasis on "relatively") unregulated land is in the Central Valley, 60 to 80 miles away.

An onerous permitting process can significantly delay developments both large and small. Scott Adams, the creator of the Dilbert comic strip, reports that it took him more than four years to gain approval to build one home in the San Francisco Bay Area.[28]

Approval of larger developments can take even longer and is highly uncertain. When San Jose drew its urban-growth boundary in 1974, it set aside a 7,000-acre area known as Coyote Valley as an "urban reserve" that supposedly would be brought into the boundary when needed. Nearly 30 years later, after inflation-adjusted housing prices had more than quadrupled, the city finally offered developers an opportunity to propose a plan for building in Coyote Valley. After spending $17 million and five years on planning, however, developers announced in 2008 that they were giving up because there was "simply too much uncertainty surrounding the plan and the market to continue as is." Developers doubted the city would have approved the plan, and even if approval were given, environmental groups were likely to delay development even further through legal challenges.[29]

A lengthy permitting process makes it impossible for developers and homebuilders to quickly respond to changes in demand. California developers responding to the increase in housing demand in 2000 were unlikely to have increased the amount of product they would have brought to market before the prices collapsed in 2006. Empty homes in states with growth-management planning are symptoms of planning delays, not of any actual housing surplus.

Legal challenges can add to both delays and uncertainties in home construction. Growth-management planners believe almost anyone should have the right to challenge development of private land on the grounds that property is really a "collective institution," says Eric Freyfogle in his book, *The Land We Share*. "When property rights trump conservation laws, they curtail the positive liberties of the majority."[30] In other words, if the majority of people decide that your land should be preserved as their "scenic viewshed," you can effectively lose the right to use it yourself.

In Oregon, for example, the courts grant standing to anyone trying to stop a development as long as they say they have some interest, however slight, in the property. In one case, a challenger was granted standing because she "pass[ed] by the property regularly" (it was on a major highway) and used nearby areas "for passive recreation, including the viewing of wildfowl."[31]

**Oregon courts grant standing to anyone who wants to challenge a proposed development, even if their only interest in the property is for birdwatching.**

These challenges have a major effect on the type of housing built in a region. Homeowners are more likely to object to new homes that cost less than their own homes, which are perceived as "bringing down the neighborhood." They also tend to oppose higher-density developments because of the potential effects on traffic and other issues. At lower densities, homes must cost more to cover the costs of land and permitting.

For example, a developer once proposed to build 2,200 homes on 685 acres in Oakland, California. After eight years, the developer finally received a permit to build 150 homes, each of which ended up selling for six times as much as the homes in the original plans.[32]

Regions that use growth management are also more likely to charge stiff developer fees to

**When planners make housing unaffordable, their first response is to require developers to sell some of their homes to low-income families.**

cover infrastructure costs. Whereas Houston developers allow homebuyers to pay off infrastructure costs over 30 years, impact fees or development charges require up-front payments often totaling tens of thousands of dollars. The difference is crucial for housing affordability: since development charges increase the cost of new housing, sellers of existing homes can get a windfall by raising the price of their houses by an amount equal to those charges, thus reducing the general level of housing affordability.

Increasing land and housing costs make other things more expensive as well. When housing is more expensive, for example, businesses must pay their employees more so that workers can afford to live in the region.

A 2002 study broke down the difference in the costs of a new home in San Jose, which has had an urban-growth boundary since 1974, and Dallas, which has zoning but whose suburbs remain, like Houston's, almost completely unregulated. Some of the key findings were as follows:

- The biggest difference was in land costs: A 7,000-square-foot lot in Dallas cost only $29,000, while a 2,400-square-foot lot in San Jose cost $232,000.
- San Jose's lengthy permitting process (and the high risk that a permit will never be issued) added $100,000 to the cost of a home in San Jose, while permitting cost less than $10,000 per home in Dallas.
- To help pay for roads, schools, and other services, San Jose charged impact fees of $29,000 per new residence, whereas Dallas charged only $5,000.
- Due mainly to high housing prices for workers, San Jose construction labor costs are higher: $143,000 for a three-bedroom house compared with $100,000 in Dallas.[33]

When planners make housing unaffordable, their first response is to impose "affordability mandates" on builders. Typically, such regulations require builders to sell 15 to 20 percent of their homes below cost to low-income buyers. Far from making housing more affordable, such mandates make it less affordable as builders build fewer homes and pass the costs on to the buyers of the other 80 to 85 percent of homes. This in turn raises the general price of housing in the region. One econometric analysis found that such affordability mandates increased housing prices by 20 percent.[34]

Land-use regulation can affect prices in other ways as well. A wide range of homebuilders compete for business in relatively unregulated markets, ranging from small companies that produce only a few homes each year, to medium-sized companies that produce a few hundred homes per year, to giant national companies that build thousands of homes in many different states. Excessive regulation tends to put the small companies out of business and discourage the national companies as well. The resulting loss of competition helps keep home prices high. Portland, Oregon's, "urban-growth boundary has really been our friend," says one mid-sized Portland homebuilder. "It has kept the major builders out of the market."[35]

Given that both demand and supply in regulated regions are inelastic, small changes in either one can result in large changes in price. If lower interest rates increase demand for housing, Houston-area homebuilders respond by building more homes; San Francisco-area builders respond by filing more applications, which may wait several years for approval. If government purchase of a large block of land for a park or open space restricts supply, Houston-area builders can simply go somewhere else nearby; in the San Francisco area, the nearest alternative building location is more than 50 miles away.

Notice that inelastic supply not only makes housing prices rapidly increase with small increases in demand; it also makes housing prices rapidly fall with small decreases in demand. This is exacerbated by lengthy permitting periods that can put homebuilders out of phase with the market. Thus, land-use restrictions create conditions ripe for housing bubbles.

Supply and demand charts only go so far in explaining bubbles. The recent bubble was probably exacerbated as much by money fleeing the post–dot-com bubble stock market than by loose credit. Investors looking for safe places to put their money quickly noted that housing prices were increasing at double-digit rates in California, Florida, and other places with growth management policies. At this point, home sales were driven by speculation as much as by the need for shelter.

For example, because of the dot-com crash, San Jose lost 17 percent of its jobs between 2001 and 2004. In the same period, office vacancy rates increased from 3 to 30 percent.[36] Yet, between the beginning of 2001 and the end of 2004, home prices increased by more than 20 percent.

This rise in prices in the face of declining demand can be attributed to speculation—that is, people buying homes as sources of income rather than for shelter. Even those who are buying for shelter will pay more for a house than its fundamental value (as measured by rents) if they believe, as the National Association of Realtors claims, that it is a safe investment. So the sharp rises in price caused by growth management turn into sharper rises caused by people seeing housing as an investment.

Houston and the San Francisco Bay Area are at the extremes of a continuum between almost no regulation and highly intrusive land-use regulation. Within that continuum, there appear to be five ways in which growth management can influence housing prices:

First, as of 2000, when housing prices were beginning to bubble, 12 states had passed growth-management or smart-growth laws, including Arizona, California, Connecticut, Florida, Hawaii, Maryland, New Jersey, Oregon, Rhode Island, Tennessee, Vermont, and Washington.[37] Those laws generally require all municipalities to write and follow growth-management plans. In a few cases, the plans are written by the state itself.

Second, most New England states have largely abandoned the county level of government. This effectively gives cities growth-management authority over the countryside around them.

Third, Nevada is a unique case where nearly all of the land in the state is owned by the federal government. The rapid growth of Las Vegas and Reno have been enabled by federal land sales, but concerns over environmental issues slowed such sales after 2000 and led to rising prices. Moreover, under the Southern Nevada Public Land Management Act of 1998, most of the revenue from land sales in Clark County (Las Vegas) is dedicated to buying open space and other amenities.[38] Since then, nearly half the revenues from land sales have been used to buy parklands, effectively requiring developers to buy two acres from the federal government to net one more acre of developable land.[39] In effect, Nevada growth management is regulated at the federal level.

Fourth, some counties or urban areas implemented growth-management plans without state mandates. Prominent examples include Denver-Boulder; Minneapolis–St. Paul; Missoula, Montana; and Charleston, South Carolina. This can produce local bubbles that are sometimes obscured when examining data at the state level.

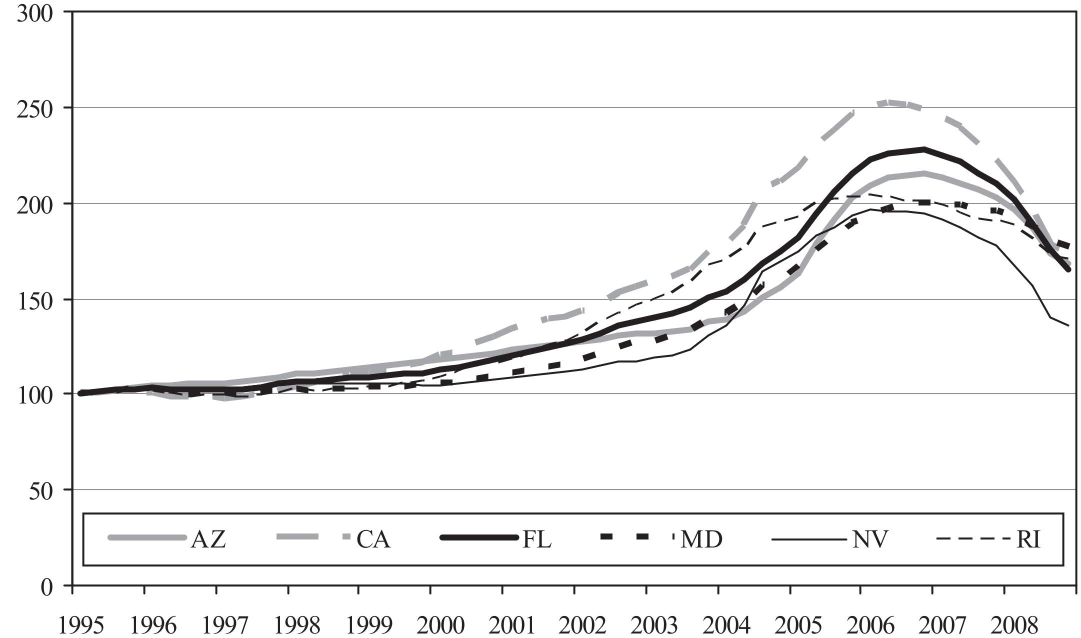
Fifth, and finally, some major urban areas may not have coordinated growth-management plans, yet they are hemmed in by state or local areas that do have such plans. Washington, DC, has no growth-management plan, but Maryland has a statewide growth-management law and selected counties in northern Virginia have also begun to practice growth management. New York has no state growth-management law, and prices in upstate New York did not bubble. But New York City prices bubbled, partly because it is hemmed in by Connecticut and New Jersey. Table 1 shows which form of growth management, if any, affects housing in each state.

## State Housing Bubbles

A careful examination of home price data for the 50 states and 384 metropolitan areas reveals strong correlations between growth-

**A 1998 federal law dedicates half the revenues from federal land sales in southern Nevada to land preservation, so developers have to buy two acres to net one developable acre.**

**Figure 3**
**State Housing Bubbles**




Source: Federal Housing Finance Agency, fourth quarter 2008 data for individual states, tinyurl.com/cb72o7.
Note: Price indices for the states with the biggest housing bubbles, with home prices in the first quarter of 1995 set to 100.

management planning and housing bubbles. The home price indices used in this and other figures are published by the Federal Housing Finance Agency (formerly the Office of Federal Housing Enterprise Oversight) and are based on the Case-Schiller method of comparing changes in prices of same-home sales over time.[40]

On a state level, the biggest housing bubbles were in six states. Five of the states—Arizona, California, Florida, Maryland, and Rhode Island—have growth-management laws, while the sixth state, Nevada (Figure 3), does not.[41] In all of these states, inflation-adjusted prices rose by 80 to 125 percent after 2000 and dropped by 10 to 30 percent after their peak.[42] Even though several of these states are located at opposite corners of the country, the price indices are very similar.

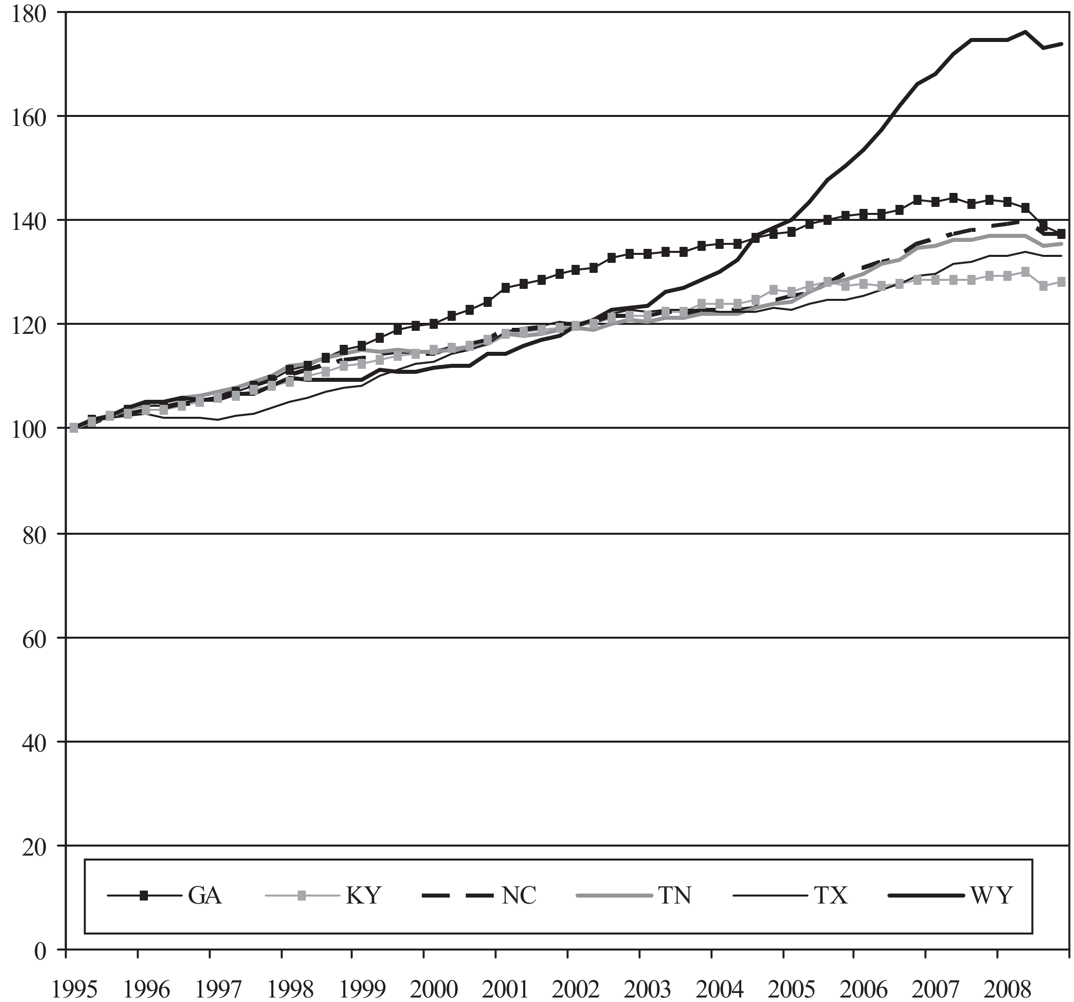
Prices in all but one of the other states with growth-management laws, including the New England states, also increased by 50 to 100 percent after 2000 and have declined since 2006, in most cases by 5 to 15 percent. The exception is Tennessee, whose price trends are nearly identical to those in Georgia and Texas (Figure 4). Tennessee housing did not bubble because its law was passed in 1998 and the urban-growth boundaries drawn by the cities were so large that they did not immediately constrain homebuilders.

In contrast, Figure 4 shows housing prices in Tennessee and several fast-growing states with no growth-management laws. Notice that the price indices appear very similar to one another but are very different from those in Figure 3.

Wyoming stands out as a state in which prices grew rapidly after 2004 and have not significantly declined. This is because the state's economy is closely tied to fossil fuel extraction, and home prices began to grow rapidly when oil prices rose in 2004. Apparently, newcomers didn't trust oil prices to remain high for long enough to justify building new homes. Cyclical housing prices are

**Housing prices bubbled in 16 states, virtually all of which have some form of growth management.**

**Figure 4**
**States without Bubbles**




Source: Federal Housing Finance Agency, fourth quarter 2008 data for individual states, tinyurl.com/ cb72o7.
Note: Price indices for states with no bubbles. Wyoming prices were boosted after 2004 because of increased oil prices. The short-term nature of such oil booms prevented newcomers from building new homes.

typical of energy-related boom-bust economies, and it is just a coincidence that this boom vaguely paralleled housing bubbles elsewhere.

Altogether, housing prices bubbled in 16 states, meaning inflation-adjusted prices grew by at least 45 percent after the beginning of 2000 and then fell by at least 5 percent after peaking (see Table 1). These 16 states housed 45 percent of the population in 2008.[43] Virtually all of these states have some form of growth management, though in some cases, such as Minnesota, it is practiced only by major urban areas in the state.

Housing prices did not bubble—meaning that prices grew by less than 45 percent after 2000—in 29 states housing nearly 54 percent of the nation. Other than Tennessee, none of these states have statewide growth management, but a few, such as Colorado and Wisconsin, contain urban areas that have written growth-management plans. The only no-

**Prices did not bubble in 29 states, only one of which has a state growth-management law.**

**Table 1**
**State Housing Bubbles and Land-Use Regulation**

| State | Price Gain | Price Decline | Bubble? | Regulation |
|---|---|---|---|---|
| Dist. of Columbia | 145.8% | -9.3% | Yes | HI |
| California | 124.3% | -31.2% | Yes | GM |
| Florida | 107.7% | -27.4% | Yes | GM |
| Hawaii | 96.2% | -8.5% | Yes | GM |
| Rhode Island | 96.0% | -16.1% | Yes | GM |
| Maryland | 93.8% | -11.6% | Yes | GM |
| Arizona | 87.1% | -21.6% | Yes | GM |
| Nevada | 86.7% | -30.8% | Yes | FL |
| New Jersey | 83.7% | -10.0% | Yes | GM |
| Virginia | 77.7% | -8.4% | Yes | UA |
| New York | 72.1% | -7.7% | Yes | HI |
| New Hampshire | 70.8% | -11.4% | Yes | NE |
| Massachusetts | 70.5% | -14.1% | Yes | NE |
| Delaware | 64.8% | -7.3% | Yes | HI |
| Vermont | 61.9% | -2.5% | Ambiguous | GM |
| Maine | 60.9% | -4.4% | Ambiguous | GM |
| Washington | 59.2% | -5.7% | Yes | GM |
| Wyoming | 58.4% | -1.3% | Ambiguous | NG |
| Connecticut | 58.2% | -8.6% | Yes | NE |
| Oregon | 55.5% | -6.7% | Yes | GM |
| Montana | 54.4% | -1.7% | Ambiguous | UA |
| Minnesota | 49.3% | -10.2% | Yes | UA |
| Idaho | 45.5% | -3.8% | Ambiguous | UA |
| Pennsylvania | 44.1% | -3.0% | No | UA |
| New Mexico | 39.0% | -3.9% | No | UA |
| Alaska | 38.6% | -3.6% | No | NG |
| Illinois | 35.1% | -5.8% | No | UA |
| Utah | 32.9% | -5.0% | No | UA |
| North Dakota | 30.6% | 0.0% | No | NG |
| Louisiana | 30.5% | -1.8% | No | NG |
| Wisconsin | 27.0% | -3.8% | No | UA |
| Colorado | 26.1% | -3.3% | No | UA |
| South Carolina | 25.9% | -2.0% | No | NG |
| South Dakota | 24.8% | 0.0% | No | NG |
| Missouri | 24.6% | -3.1% | No | NG |
| Georgia | 22.7% | -4.8% | No | NG |
| West Virginia | 22.1% | -3.2% | No | NG |
| North Carolina | 22.1% | -1.4% | No | NG |
| Alabama | 21.8% | -0.8% | No | NG |
| Texas | 21.5% | -0.4% | No | NG |
| Arkansas | 20.4% | -2.3% | No | NG |
| Oklahoma | 20.3% | -1.8% | No | NG |
| Mississippi | 20.2% | -2.0% | No | NG |
| Tennessee | 19.4% | -1.3% | No | GM |

**Table 1** ***Continued***

| State | Price Gain | Price Decline | Bubble? | Regulation |
|---|---|---|---|---|
| Michigan | 15.7% | -19.4% | No | NG |
| Kansas | 15.4% | -2.2% | No | NG |
| Kentucky | 14.6% | -1.3% | No | NG |
| Iowa | 13.2% | -1.7% | No | NG |
| Nebraska | 9.7% | -4.4% | No | NG |
| Ohio | 9.0% | -9.4% | No | NG |
| Indiana | 6.5% | -4.8% | No | NG |

Notes: States are listed in descending order of price gain, that is, the increase in home prices from the first quarter of 2000 to the peak; price decline is the decrease in prices from the peak to the second quarter of 2008. States that gained less than 75 percent are classified "no"; the remaining states are "ambiguous." Regulatory status is: FL=state dominated by federal land; GM=mandatory state growth-management law; HI=urban areas hemmed in by other states with growth management; NE=New England (weak county governments); NG=no growth management; UA=selected urban areas practice growth management (including Denver and Boulder, CO; Boise, ID; Chicago, IL; Minneapolis–St. Paul, MN; Missoula and Whitefish, MT; Albuquerque and Santa Fe, NM; Philadelphia, PA; Charleston, SC; Salt Lake City, UT; northern Virginia; and Madison and Milwaukee, WI).

bubble states with significant price declines are Michigan and Ohio, and those declines are due to contractions in manufacturing, not a housing bubble.

The remaining five states, whose prices rose by more than 45 percent but shrank by less than 5 percent, are ambiguous. These states house less than 2 percent of the population and include one with a growth-management law (Vermont), one with no growth management (Wyoming), and three with controls in a few urban areas (Idaho, Maine, and Montana).[44]

There is a strong correlation between foreclosure rates and growth-management-induced housing bubbles. As of January 2009, one out of every 173 homes in California was in foreclosure. The rate in Arizona was 1 in 182; Florida was 1 in 214; Nevada was 1 in 76; and Oregon was 1 in 357—all of which are worse than Michigan (1 in 400), despite the latter having the nation's highest unemployment rate. By comparison, barely 1 in 1,000 Texas homes was in foreclosure. The rate in Georgia was 1 in 400, North Carolina was 1 in 1,700, and Kentucky was 1 in 2,800. The correlation is not perfect, but the hardest-hit states all have some form of growth-management planning.[45]

## Metropolitan Area Housing Bubbles

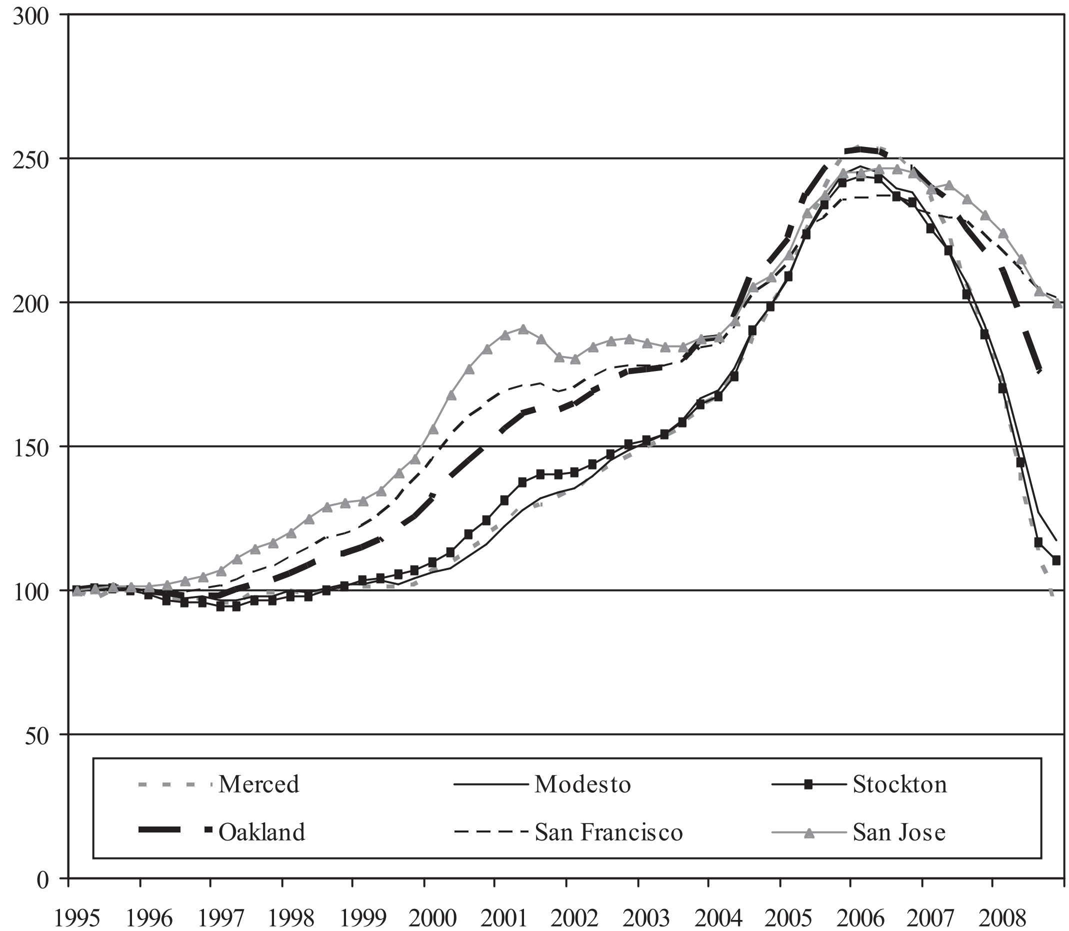
Figure 5 shows home price trends in the San Francisco Bay area and the Merced, Modesto, and Stockton metropolitan areas in central California. The latter areas enjoyed some of the biggest price increases after 2000 and suffered the largest price declines since the top of the housing bubble.[46]

In 1963, the California legislature passed a law effectively (though unintentionally) authorizing cities and counties to do growth-management planning.[47] The counties in the San Francisco Bay Area used this law to impose urban-growth boundaries in the mid 1970s. This made Bay Area housing some of the most expensive in the nation, and by the 1990s, increasing numbers of Bay Area workers were buying homes in relatively affordable central California, some 50 to 80 miles away.

Central California counties were less prone to adopt strict growth-management plans. But in 2000, the California legislature amended the law to mandate growth-management planning by all cities and counties. This new mandate, combined with the overflow from the Bay Area, caused central

**There is a strong correlation between foreclosure rates and growth-management-induced housing bubbles.**

**Figure 5**
**Central California and Bay Area Housing Bubbles**




Source: Federal Housing Finance Agency, fourth quarter 2008 data for metropolitan statistical areas, tinyurl.com/dkr3gg.
Note: Price indices for Merced, Modesto, and Stockton.

**Between 2000 and 2008, the Atlanta, Dallas-Ft. Worth, and Houston metro populations each grew by more than 125,000 per year without experiencing housing bubbles.**

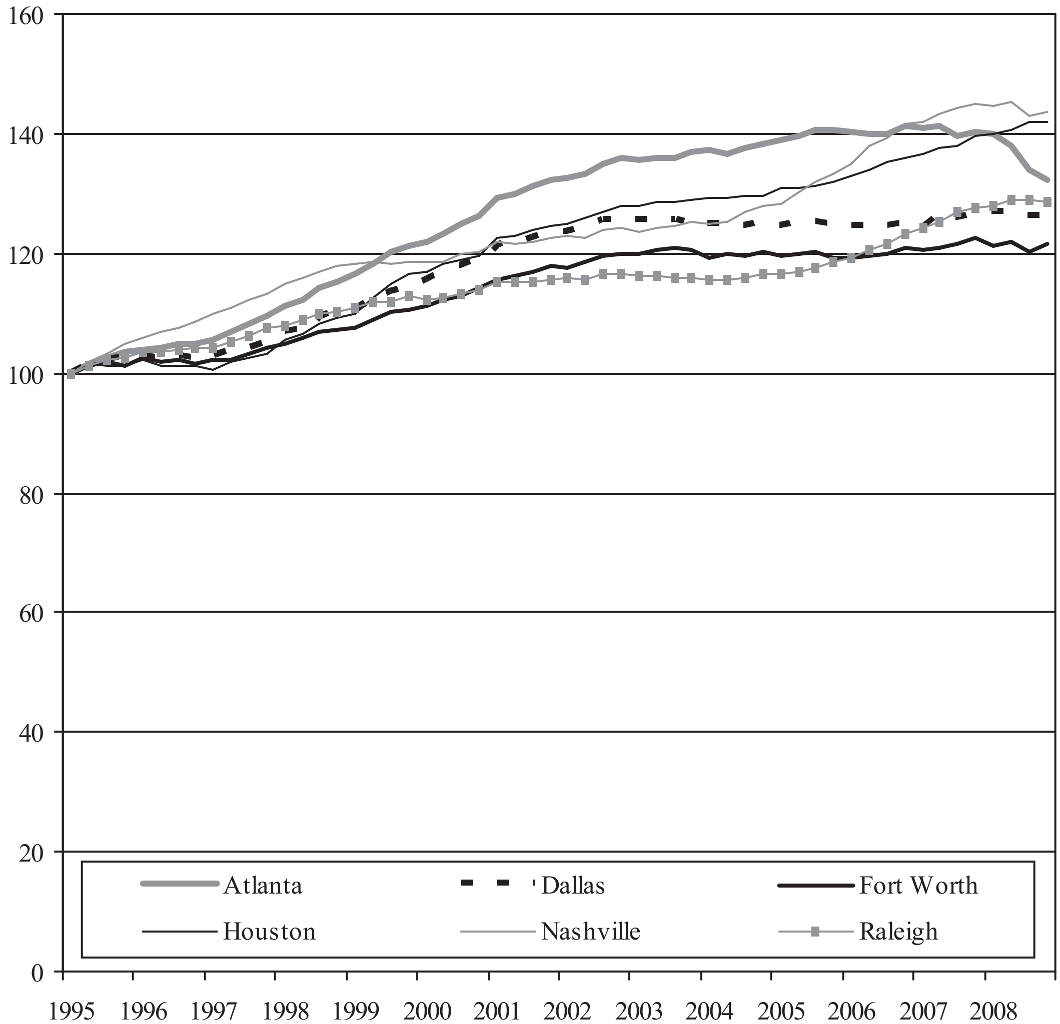
California home prices to bubble with special vigor, with prices rising during the boom and falling during the bust by more, on a percentage basis, than anywhere else in the country.

Although prices certainly bubbled in the San Francisco Bay Area, the bubble was not as severe. This illustrates a "first-in, last-out" phenomenon: since housing in the Central Valley, with its 80-mile-one-way commutes to jobs in San Francisco and San Jose, was less desirable to begin with, it experienced greater price declines than in the cities where the best jobs were located.

In contrast, Figure 6 tracks housing prices in the Atlanta, Dallas, Ft. Worth, Houston, Nashville, and Raleigh metropolitan areas. Although a very slight increase in price growth can be discerned in late 1997, prices did not significantly bubble upwards, nor has there been a significant decline in prices in recent years (although Atlanta prices fell by 0.7 percent in the second quarter of 2008).

The lack of a housing bubble in those metro areas is not because they are unpopular places to live. In fact, between 2000 and 2008, the Atlanta, Dallas–Ft. Worth, and Houston metro area populations each grew

**Figure 6**
**Metropolitan Areas with No Bubbles**




Source: Federal Housing Finance Agency, fourth quarter 2008 data for metropolitan statistical areas, tinyurl.com/dkr3gg.
Note: Price indices for Atlanta, Dallas, Ft. Worth, and Houston.

by more than 120,000 people per year. Along with Nashville and Raleigh, these regions are all growing faster than 2 percent per year. By comparison, the San Francisco Bay area (the combined Oakland, San Francisco, and San Jose metro areas) grew by less than 20,000 people (0.4 percent) per year and central California (the combined Merced, Modesto, and Stockton metro areas) grew by less than 30,000 people (1.9 percent) per year.[48]

Atlanta, Dallas–Ft. Worth, and Houston were just as influenced by low interest rates, predatory lenders, and other changes in the credit market as Merced, Modesto, and Stockton. It may be that changing credit rules are responsible for the slight increase in the growth of housing prices after 1997. The trend lines in Figures 4 and 6 are likely what would have happened all over the country were it not for governmental restraints on new home construction.

Almost all other housing bubbles were in urban areas hemmed in by states with growth-management laws. New York State has no

**The trend lines in Figures 4 and 6 are likely what would have happened throughout the country were it not for government restraints on new home construction.**

**French economist Vincent Benard says that land-use regulations "appeared to be, by far, the main factor explaining" the housing bubble in France.**

such law, and most of its urban areas did not experience bubbles. But New York City and its immediate suburbs (Poughkeepsie, Nassau-Suffolk) did, as their expansion is partly controlled by Connecticut and New Jersey. Similarly, Washington, DC, is bordered by Maryland, which has a state growth-management law, and Virginia, whose northern counties have imposed large-lot zoning to prevent urban expansion into rural areas.

Bubbles—prices growing more than 45 percent and then declining more than 5 percent—took place in 115, or 30 percent, of the nation's 384 metro areas. Those areas house 46 percent of the metropolitan population.[49] All but a handful of these were in states that were subject to some form of growth management. The few that were not, such as Myrtle Beach, South Carolina, and Wilmington, North Carolina, may have had some local growth-management programs.[50]

No-bubble metro areas numbered 245 and include 50 percent of metro area residents. Only a handful of these, such as Salem and Corvallis, Oregon, and Longview, Washington, were in states that had some form of growth management. Most regions that saw prices decline by more than 10 percent are in Michigan, and this is due to the auto industries' troubles, not to a housing bubble.

The remaining 24 urban areas are in the ambiguous category and include a mixture of areas with and without growth management. Prices in growth-managed Charleston, South Carolina, and Missoula, Montana, for example, increased more than 50 percent but only declined by a little more than 4 percent. Larger declines are likely in those areas before the market bottoms out. On the other hand, prices in unregulated Casper, Wyoming, and Midland, Texas, grew by around 70 percent and have hardly declined. Those cities' economies are based on fossil fuel production, which stepped up after 2004 with the increase in oil prices.

In short, there is a very close correlation between regions with growth-management planning and regions that have seen a major housing bubble. Without growth management, prices in a few parts of the country, such as Casper and Midland, would have grown because of local factors; and prices in other parts, such as Michigan, would have declined because of local factors.

In most of the country, however, prices without growth management would have looked like those in Figures 4 or 6. There might have been some subprime mortgage defaults—particularly in Michigan—but there would have been no major housing bubbles, no credit crisis, no need for a bank bailout, and no worldwide recession.

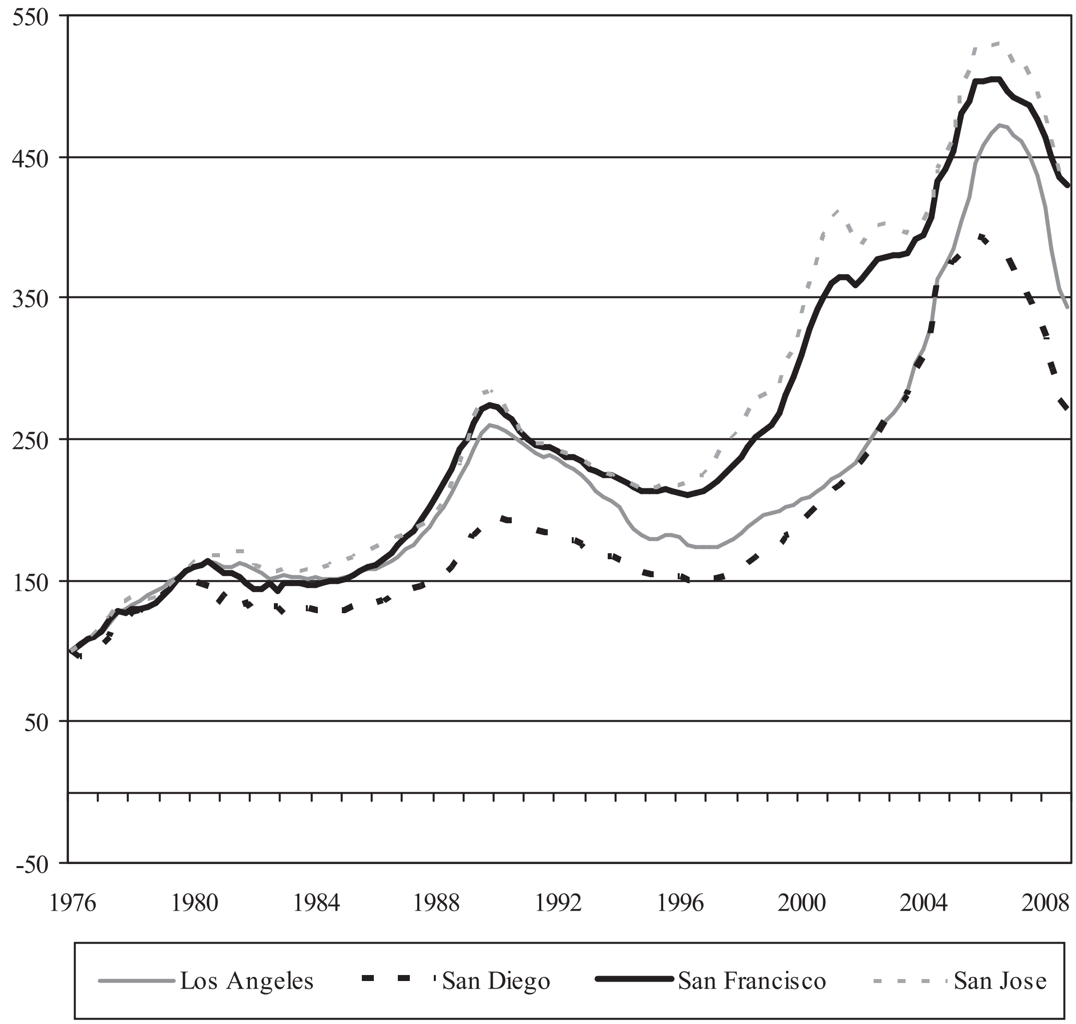
## Housing Bubbles in Other Countries

The United States is not the only country whose planners use growth-management tools, and it is not the only country to have a housing bubble. "Two thirds (by economic weight) of the world . . . has a potential housing bubble," observed *The Economist* in 2004.[51] Great Britain has used growth management since 1947, and it underwent a severe housing bubble. Much of continental Europe, Australia, and New Zealand have similar land-use policies and also have had housing bubbles.

Vincent Benard, of l'Institut Hayek, observes that French land-use authorities write plans every 10 to 15 years. If there is a surge in demand between the rewrites, the plans may fail to have enough land available to accommodate new development. A six-year permitting process further contributes to long lags between new demand and the time homebuilders can meet that demand. As a result, land-use regulations "appeared to be, by far, the main factor explaining" the French housing bubble.[52]

Canada, like the United States, does not have a national land-use policy. But some urban areas, notably Vancouver and Toronto, practice growth management. These two regions have the most expensive housing in the nation, with a typical home in Vancouver costing four times as much as a similar home in Ottawa, the nation's capital, and five times as much as a similar home in Montreal.[53]

**Figure 7**
**California Housing Bubbles**




Source: Federal Housing Finance Agency, fourth quarter 2008 data for metropolitan statistical areas, tinyurl.com/dkr3gg.

Vancouver home prices peaked in 2007 and declined by 10 percent in 2008.[54]

In a recent survey of 227 housing markets around the world, former governor of the New Zealand Reserve Bank Donald Brash observes that "the affordability of housing is overwhelmingly a function of just one thing, the extent to which governments place artificial restrictions on the supply of residential land."[55] Using the same data, Wendell Cox shows that "one of the most important factors" in the mortgage meltdown around the world has been "the role of excessive land-use regulations in exacerbating the extent of losses."[56]

## Housing Bubbles in the Past

Growth management was a necessary condition for most or all of the housing bubbles American communities have seen in the last decade. Beyond that, growth management was part of several housing bubbles well before 2000. Those bubbles took place before the

**"The affordability of housing," says former New Zealand central banker, "is a function of the extent to which governments place artificial restrictions on the supply of residential land."**

**Land-use restrictions not only make housing unaffordable, they make prices more volatile.**

loosening of credit that many claim caused the recent bubble. The difference between earlier bubbles and the recent one is that fewer states were practicing growth management in earlier decades, and so a much smaller share of American housing suffered from such bubbles.

Figure 7 shows two earlier bubbles in the Los Angeles, San Diego, San Jose, and San Francisco metropolitan areas. The first was when prices grew in the late 1970s in response to the original imposition of urban-growth boundaries. Prices fell in the early 1980s. Then prices bubbled again, peaking in 1990 and crashing again through 1995. Silicon Valley suffered a small bubble that peaked in 2001, but this was really just a part of the most recent bubble.

Again, there is a close correlation between bubbles and growth management. The bubble that peaked in 1980 took place in California, Hawaii, Oregon, and Vermont—the only states that were practicing growth management in the 1970s. By the 1980s, several New England states and a few urban areas, including Seattle, began practicing growth management, and they joined in the bubble that peaked in 1990. Few, if any, states or urban areas that were not practicing growth management had housing bubbles before 2000.

Foreign countries that practice growth management have also had previous bubbles. Norway, Sweden, and Finland had property bubbles that peaked in 1990 and were severe enough to send virtually all of the nations' banks into bankruptcy.[57] Japanese policies aimed at preventing the development of rural land included 150 percent capital gains taxes on short-term property gains.[58] The resulting property bubble and inevitable collapse led to a decade-long recession.

Several studies have tied volatility to land-use regulation. A 2005 economic analysis of the housing market in Great Britain, which has practiced growth management since 1947, found that planning makes housing markets more volatile. "By ignoring the role of supply in determining house prices," the report says, "planners have created a system that has led not only to higher house prices but also to a highly volatile housing market."[59]

Economists Edward Glaeser and Joseph Gyourko have found similar results in the United States. Land-use rules that restrict "housing supply lead to greater volatility in housing prices," they say, adding that, "if an area has a $10,000 increase in housing prices during one period, relative to national and regional trends, that area will lose $3,300 in housing value over the next five-year period."[60] Both the Great Britain and the Glaeser-Gyourko studies were based on data preceding the current housing bubble.

## Responding to Unaffordability

Because prices do not decline as much in crashes as they increase in booms, successive bubbles can make housing grotesquely unaffordable. In 1969, the nation's least-affordable metropolitan area, with a median-home-value-to-median-family-income ratio of 3.2, was Honolulu, mainly because of Hawaii's 1961 growth-management law. As previously noted, most other metropolitan areas had ratios of 1.5 to 2.5.

By 1979, after Oregon and California had implemented growth management plans, the Honolulu value-to-income ratio was 5.5, at which point it became virtually impossible for a median family to get a mortgage on a median home given the terms typical of the day. In much of California, 1979 value-to-income ratios were between 4 and 5, while they had reached 3.2 (Honolulu's 1969 ratio) in some Oregon communities.

Despite the decline in real California and Hawaii home prices in the early 1980s, the late-1980s bubble pushed California value-to-income ratios to as high as 6.7 in San Francisco (compared with 6.2 in Honolulu) and well above 4 in much of the rest of California. This bubble also pushed prices in Boston, New York, and nearby metro areas above 4. Oregon, which suffered a greater recession in the early 1980s than most states, did not have a late-1980s bubble.

Prices in California, Hawaii, and the Northeast crashed in the early 1990s, but by 1999 value-to-income ratios had recovered and were poised for another leap. By 2006, price-to-income ratios throughout California and Hawaii ranged from 5 to as high as 11.5. In response to growth-management plans written in the mid- to late-1990s, value-to-income ratios in Arizona, Florida, Maryland, and Washington ranged from 3 to 5.5.

The pattern is clear: each successive bubble pushes value-to-income ratios further away from the natural ratio of about 2.0. Even at the bottom of the cycle in 1995, many California value-to-income ratios were well above 5, meaning that housing was still unaffordable despite the crash of the early 1990s.

Much media attention has focused on the Community Reinvestment Act of 1977 and its role in encouraging banks to make risky loans to low-income families. Just as important is how the Department of Housing and Urban Development responded to the growing housing affordability crisis by encouraging banks to loosen their criteria for making loans to *moderate-income* families that were priced out of housing markets by growth-management planning.

In 1992, Congress gave the Department of Housing and Urban Development the responsibility for regulating Fannie Mae and Freddie Mac (collectively known as government-sponsored enterprises, or GSEs) to ensure that they did not engage in risky behavior. But this conflicted with HUD's primary mission, which "is to increase homeownership, support community development, and increase access to affordable housing free from discrimination."[61]

As successive HUD secretaries became aware of housing affordability problems in California and other parts of the country, they used their regulatory authority to order the GSEs to buy more loans from "low- and moderate-income families." Specifically, in 1995, Secretary Henry Cisneros ordered that at least 42 percent of the mortgages purchased by the GSEs had to be from low- and moderate-income families. In 2000, Secretary Andrew Cuomo increased this to 50 percent.[62] In 2004, Secretary Alphonso Jackson increased it yet again to 58 percent.[63]

One response to these rules was an increase in Fannie Mae and Freddie Mac purchases of subprime loans, meaning loans made to people with poor credit histories. But another response was to relax the loan criteria for prime loans, that is, loans to people with excellent credit histories who nonetheless had a hard time buying houses in unaffordable states like California. Before 1995, Fannie Mae and Freddie Mac would normally buy only 15- to 30-year mortgages with at least 10 percent down and monthly payments (plus insurance and property taxes) that were no more than about 33 percent of the homebuyer's income.

When brand-new starter homes cost $110,000, as they do in Houston, a 10 percent down payment is not a formidable obstacle. When starter homes cost closer to $400,000, as they did in the San Francisco Bay Area in the late-1990s, the obstacle is much greater. Value-to-income ratios of 5 and above require 40- to 50-year payment periods and/or mortgages that cost more than 33 percent of a family's income.

The result was that mortgage companies greatly reduced the criteria required to get loans. They no longer required 10 percent down payments. People could get loans for 40 and even 50 years. And borrowers could dedicate well over half their incomes to their mortgages. These changes allowed people to buy homes that were five or six times their incomes, but they also increased the risks of defaults even among supposedly prime borrowers.

**By eliminating the requirement that homebuyers make at least a 10 percent down-payment, Fannie Mae and Freddie Mac increased the risk of defaults.**

Such regulatory actions would not have been necessary if growth management had not made a substantial portion of American housing unaffordable. While urban planners had nothing to do with credit default swaps or other derivatives, they are directly responsible for unaffordable housing and indirectly responsible for the government's loosening of credit standards in response to that unaffordability.

## Should Government Stabilize Home Prices?

When financial markets melted down in October 2008, several economists argued that

**Though some people want to stabilize housing prices, the reality is that housing remains much too expensive in virtually all of the bubble markets.**

the solution was to "stabilize home prices."[64] In February 2009, President Obama announced a plan that aimed to "shore up housing prices" and "arrest this downward spiral."[65] When potential homeowners refuse to buy homes until the market bottoms out, it is easy to see why some people might think that the problem with the nation's housing markets is falling prices.

Yet the reality is that—in terms of median-home-price-to-median-income ratios—housing remains much too expensive in virtually all of the bubble markets. Such expensive housing puts hardships on consumers, and as Portland economist Randall Pozdena notes, those hardships fall hardest on poor, minority, and working-class families.[66] The benefits gained by homesellers who earn windfall profits because of artificial housing shortages are unfair because existing homeowners tend to be wealthier than first-time home buyers. Moreover, those benefits do not entirely offset the costs, some of which, such as the cost of an onerous permitting process, are simply deadweight losses to society.

Furthermore, housing is only one symptom of the problems created by growth-management policies. Such policies impose the same sorts of hardships on businesses that need land and structures for offices, factories, stores, and other purposes.

Glaeser and Gyourko agree that an effort to stabilize housing prices is a bad idea. They point out that most of the tools government would use to support housing prices, such as reduced interest rates or more favorable loans, would be extremely costly yet have only marginal and uncertain effects on housing. "This is a bad combination," they dryly observe.[67]

The biggest reason to oppose price stabilization is that it contradicts other government policies. "Housing affordability has long been a stated goal of the federal government," Glaeser and Gyourko point out. "Why should it now try to make it more difficult for people to buy, or rent, a home by supporting prices?"[68] The real problem, they add, "is not the price decline but the previous price explosion."[69]

Of course, the reason housing prices are high in most areas that suffered housing bubbles is because of explicit government policies aimed at discouraging construction of new single-family homes. Rightly or wrongly, high housing prices serve this agenda, so government efforts to promote homeownership are undermined by other government efforts to discourage it.

As an alternative, "home prices must get back to pre-bubble levels," suggests Harvard economist Martin Feldstein. But, he adds, "Congress should enact policies to reduce defaults that could drive prices down much further."[70] Yet such policies carry the same perils as efforts to stabilize prices—especially since pre-bubble prices in several states and urban areas were already well above normal value-to-income ratios.

Table 2 shows value-to-income ratios by state in 1999, when the bubble was in an incip-

**Table 2**
**Median Home Value to Median Family Income Ratios**

| State | 1999 | 2006 | 2008 |
|---|---|---|---|
| Alabama | 1.8 | 2.1 | 2.2 |
| Alaska | 2.3 | 3.1 | 3.2 |
| Arizona | 2.3 | 4.4 | 3.4 |
| Arkansas | 1.7 | 2.1 | 2.1 |
| California | 3.8 | 8.3 | 5.5 |
| Colorado | 2.9 | 3.7 | 3.5 |
| Connecticut | 2.5 | 3.7 | 3.5 |
| Delaware | 2.2 | 3.5 | 3.5 |
| Dist. of Columbia | 3.3 | 7.3 | 6.3 |

**Table 2** ***Continued***

| State | 1999 | 2006 | 2008 |
|---|---|---|---|
| Florida | 2.0 | 4.2 | 3.0 |
| Georgia | 2.0 | 2.5 | 2.4 |
| Hawaii | 4.4 | 8.7 | 7.8 |
| Idaho | 2.3 | 4.2 | 4.2 |
| Illinois | 1.8 | 2.2 | 2.2 |
| Indiana | 1.7 | 1.8 | 1.8 |
| Iowa | 2.3 | 2.4 | 2.4 |
| Kansas | 1.6 | 1.9 | 1.9 |
| Kentucky | 1.9 | 2.2 | 2.2 |
| Louisiana | 1.9 | 2.4 | 2.4 |
| Maine | 2.1 | 3.2 | 3.2 |
| Maryland | 2.3 | 4.3 | 3.7 |
| Massachusetts | 3.0 | 4.8 | 4.1 |
| Michigan | 2.1 | 2.4 | 2.1 |
| Minnesota | 2.1 | 3.1 | 2.7 |
| Mississippi | 1.7 | 2.2 | 2.1 |
| Missouri | 1.9 | 2.3 | 2.3 |
| Montana | 2.4 | 3.4 | 3.4 |
| Nebraska | 1.8 | 1.9 | 1.9 |
| Nevada | 2.6 | 5.0 | 3.3 |
| New Hampshire | 2.2 | 3.6 | 3.1 |
| New Jersey | 2.6 | 4.5 | 4.1 |
| New Mexico | 2.4 | 3.3 | 3.2 |
| New York | 2.9 | 4.9 | 4.3 |
| North Carolina | 2.1 | 2.5 | 2.6 |
| North Dakota | 1.6 | 1.8 | 1.9 |
| Ohio | 2.0 | 2.2 | 2.1 |
| Oklahoma | 1.7 | 1.9 | 2.0 |
| Oregon | 3.0 | 4.4 | 4.5 |
| Pennsylvania | 1.9 | 2.7 | 2.7 |
| Rhode Island | 2.5 | 4.7 | 3.8 |
| South Carolina | 1.9 | 2.3 | 2.4 |
| South Dakota | 1.7 | 2.0 | 2.1 |
| Tennessee | 2.0 | 2.4 | 2.5 |
| Texas | 1.7 | 2.0 | 2.1 |
| Utah | 2.8 | 3.6 | 3.8 |
| Vermont | 2.3 | 3.4 | 3.5 |
| Virginia | 2.2 | 3.8 | 3.4 |
| Washington | 3.0 | 4.6 | 4.4 |
| West Virginia | 1.8 | 2.0 | 2.1 |
| Wisconsin | 2.1 | 2.7 | 2.6 |
| Wyoming | 2.0 | 2.7 | 3.0 |

Source: 1999 home values and family incomes from the 2000 census. Median incomes for 2006 and 2008 from "Income Limits," Department of Housing and Urban Development, 2006 and 2008, tinyurl.com/c7rjvp. Home values for 2006 and 2008 were calculated from 1999 census values using home price indices from the Federal Housing Finance Agency, tinyurl.com/cydm8h.

ient stage; 2006, when it reached its peak in many places; and the last quarter of 2008. In 1999, only 4 states had average value-to-income ratios of three or more, and only 1 state was greater than four. By 2006, home values in 24 states were three times incomes and 13 states were greater than four. As of the last quarter of 2008, values in 24 states were still at least three times median incomes and eight states were greater than four. So prices still have to fall to get back to 1999 levels of affordability, and in a few states they should fall even further to value-to-income ratios lower than three.

Planners argue that growth management helps preserve open space and reduces the amount of driving people need to do. Yet the share of U.S. land that would be protected from urbanization through denser housing is miniscule—probably less than 1 percent—and the effects of density on driving are also small.

**Housing bubbles are due solely to supply problems, not to changes in housing demand.**

The negative effects of growth management—on housing prices, on the costs of doing business, on congestion, and on personal liberty—are far greater than the benefits, most of which can be achieved in other ways at a far lower cost. Rather than prop up housing prices, then, the current recession is an excellent time to start the discussion of how housing prices in areas with growth management can be returned to normal, affordable levels.

## Planners' Response

Many urban planners steadfastly deny that their growth-management policies make housing more expensive. Instead, they claim that higher-priced housing is solely due to increased demand resulting from the quality-of-life improvements resulting from their policies. As Paul Danish, the city council member whose plans made Boulder, Colorado, housing less affordable than 90 percent of the other urban areas in the United States, says, Boulder housing prices are high solely because it is "a really desirable place to live," while anywhere else with lower prices is "a really awful place to live."[71]

In reality, housing bubbles are solely due to supply problems. When the supply of new homes is elastic, an increase in demand should not result in a significant increase in price. There are several reasons why supply may be inelastic, but most of them relate to land-use regulation or other government policies that keep land unavailable for housing. Preventing future housing bubbles and the economic instability they cause will require dismantling those growth-management policies.

Ironically, many planning advocates are using declining home prices as an argument in favor of more growth-management planning. They observe that most of the households in the high-density housing projects favored by smart-growth plans have no children, and that an increasing share of American households is childless. They therefore reason that the share of households that want single-family homes is about to decline drastically, and the recent drop in housing prices is a symptom of that decline.

A prime example is Arthur Nelson, an urban planning professor at the University of Utah, whose projection of 22 million "surplus" suburban homes by 2025 was cited in *Time* and *Atlantic Monthly*. That projection is based on a table in a paper by Nelson titled "Summary of Housing Preference Survey Results." The table says that 38 percent of Americans prefer multifamily housing, 37 percent prefer homes on small (less than one-sixth acre) lots, and 25 percent prefer homes on large lots. A note to the table says it "is based on interpretations of surveys by Myers and Gearin (2001)."[72]

However, Myers and Gearin's paper, which reviews surveys of housing preferences, hardly supports Nelson's table. "Americans overwhelmingly prefer a single-family home on a large lot," concludes one survey they cite. Others found that "83 percent of respondents in the 1999 National Association of Home Builders Smart Growth Survey prefer a single-family detached home in the suburbs"; "74 percent of respondents in the 1998 Vermonters Attitudes on Sprawl Survey preferred a home in an outlying area with a larger lot"; and "73 percent of the 1995 American Lives New

Urbanism Study respondents prefer suburban developments with large lots."[73]

Indeed, the main point of Myers and Gearin's article is not that most Americans want to live on small lots or in multifamily homes, but only that there is a contingent of Americans who do prefer such housing. "Some housing consumers actually prefer higher density," they report.[74] They also speculate that people are more likely to join that group as they get older. However, their evidence for this is sketchy: surveys showing that older people are "receptive to decreased auto dependence."[75] Being "receptive" is far from choosing to live in higher densities; the same Vermont survey that reported 74 percent of people want to live on a large lot found that 48 percent want to be within walking distance of stores and services.[76] These two preferences are incompatible, and most Americans have picked the large lot over walking distance to stores.

The information used by Nelson "may not be terribly reliable," comments Emil Malizia, a planning professor at the University of North Carolina. "The samples are self-selected" he says, "the responses may be heavily influenced by the data collection method," and "people often do not behave in ways that are consistent with the preferences or opinions they express."[77]

So the claim that the nation will soon have a huge surplus of large-lot homes is based on, at best, a misinterpretation of the data. Nelson uses this misinterpretation to urge planners to design a new "template" for future development and redevelopment that focuses on higher densities and mixed-use developments.[78] In short, Nelson promotes his erroneous data to justify growth-management policies that will increase the scarcity of single-family homes despite the reality that these are the homes most Americans prefer.

## The Next Housing Bubble

The prime cause of the housing bubble that generated the recent financial crisis was overregulation of land that created artificial shortages of housing. Over the last decade, housing prices have bubbled in almost every state and region that has attempted to regulate growth, while very few areas that haven't practiced growth management have seen housing prices rise and crash. Prices have also bubbled in other countries with managed growth policies, as well as in past decades in the few states that attempted to manage growth before 1990.

Understanding that growth management caused the housing bubble that led to the recent economic crisis provides little help in solving the crisis. But it can help in preventing future housing bubbles and economic crises.

As previously noted, Tennessee passed a growth-management law in 1998 but did not experience a housing bubble. In the next economic boom, however, Tennessee is likely to join the bubble club. So will any other states that are persuaded by local chapters of the American Planning Association to pass similar laws. The APA has written "model statutes" for such planning as well as a guidebook to help planners generate "grassroots support" for laws that give them more power to manage growth.[79]

On top of this, the California legislature recently passed a bill mandating even stricter growth management on the unproven (and unlikely) premise that ever-denser housing will reduce greenhouse gas emissions.[80] This bill is regarded as a model for other states and some in Congress have proposed to incorporate some of its concepts into federal law.

If present trends continue, then, the next housing bubble is likely to affect an even greater percentage of American housing. It is also likely to push value-to-income ratios even higher, with ratios reaching 14 or 15 in the San Francisco Bay Area, 10 in much of the rest of California, and 6 or more in Florida and other states that experienced their first bubble in the last decade.

If problems with derivatives are fixed, the next housing bubble might not cause an international financial meltdown. Yet, as Edward Chancellor observes in *Devil Take the Hindmost*, "speculation demands continuing govern-

**Despite the relationship between growth management and housing bubbles, the American Planning Association is urging more states to pass such laws.**

**While low-cost housing markets maintain a diversity of incomes, lower- and middle-income people are migrating away from high-cost markets.**

ment restrictions, but inevitably it will break any chains and run amok."[81] Even if the next bubble does not cause an international crisis, it will impose severe hardships on homebuyers, turn ordinarily stable regions into boom-bust economies, increase the costs to businesses, and greatly restrict personal choice and freedom.

It will also greatly transform urban areas, and not for the better. As Joel Kotkin has documented, while low-cost housing markets maintain a diversity of incomes, lower- and middle-income people are migrating away from San Francisco and other high-cost markets.[82] This is turning these places, says one demographer, into "Disneylands for yuppies."[83] Some could argue that this helps to create a diverse array of communities, but the alternative view (as expressed by Glaeser) is that it makes the affected regions "less diverse" and turns them into "boutique cities catering only to a small, highly educated elite."[84]

## Conclusions

Housing bubbles triggered the financial meltdown of 2008. Those bubbles did not result from low interest rates, changes in mortgage requirements, or other factors influencing demand. Instead, a necessary condition for their formation was supply shortages, most of which resulted from urban planners engaged in what they considered to be state-of-the-art growth-management planning. The United States is fortunate that they were able to practice these policies in only about 16 states, else the costs of the financial crisis would be even greater.

The best thing the government can do is allow home prices to fall to market levels. To do this, states and urban areas with growth-management laws and plans should repeal those laws and dismantle the programs that made housing expensive in the first place. This will obviously be easier to do in states like Florida, where value-to-income ratios have returned to affordable levels, than in California, where housing remains unaffordable. But repealing California's grotesque planning laws will probably help kick-start its economy, which in many respects is in even worse shape than Michigan's.

States and regions that have been considering growth-management laws and plans should firmly reject them. Both Congress and the states should reject proposals to impose California-style policies aimed at creating more compact cities, supposedly to reduce driving and greenhouse gas emissions. The costs of such policies will be extremely high and their beneficial effects will be negligible.

Bubbles and credit crises happen too often as it is. Governments should not increase their frequencies and depths by creating artificial housing and real estate shortages.

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Policy Analysis

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Routing

# Does Rail Transit Save Energy or Reduce Greenhouse Gas Emissions?

by Randal O'Toole

## Executive Summary

Far from protecting the environment, most rail transit lines use more energy per passenger mile, and many generate more greenhouse gases, than the average passenger automobile. Rail transit provides no guarantee that a city will save energy or meet greenhouse gas targets.

While most rail transit uses less energy than buses, rail transit does not operate in a vacuum: transit agencies supplement it with extensive feeder bus operations. Those feeder buses tend to have low ridership, so they have high energy costs and greenhouse gas emissions per passenger mile. The result is that, when new rail transit lines open, the transit systems as a whole can end up consuming more energy, per passenger mile, than they did before.

Even where rail transit operations save a little energy, the construction of rail transit lines consumes huge amounts of energy and emits large volumes of greenhouse gases. In most cases, many decades of energy savings would be needed to repay the energy cost of construction.

Rail transit attempts to improve the environment by changing people's behavior so that they drive less. Such behavioral efforts have been far less successful than technical solutions to toxic air pollution and other environmental problems associated with automobiles.

Similarly, technical alternatives to rail transit can do far more to reduce energy use and CO2 outputs than rail transit, at a far lower cost. Such alternatives include the following:

- Powering buses with hybrid-electric motors, biofuels, and—where it comes from nonfossil fuel sources—electricity;
- Concentrating bus service on heavily used routes and using smaller buses during off-peak periods and in areas with low demand for transit service;
- Building new roads, using variable toll systems, and coordinating traffic signals to relieve the highway congestion that wastes nearly 3 billion gallons of fuel each year;
- Encouraging people to purchase more fuel-efficient cars. Getting 1 percent of commuters to switch to hybrid-electric cars will cost less and do more to save energy than getting 1 percent to switch to public transit.

If oil is truly scarce, rising prices will lead people to buy more fuel-efficient cars. But states and locales that want to save even more energy and reduce greenhouse gas emissions will find the above alternatives far superior to rail transit.

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**Twentieth-century streetcar companies knew what many American cities have forgotten today: buses cost less, can run on faster schedules, and are more flexible than rail service.**

## Introduction

Once upon a time, so the story goes, evil automobile and oil companies bought up the nation's efficient streetcar lines and dismantled the trolley systems that commuters loved in order to force people to buy cars and gasoline instead.[1] The moral of this oft-repeated fairy tale is that we should unshackle ourselves from slavery to auto dependency and petrodominance by building modern light rail, streetcar, and other rail transit lines.

The truth is that the streetcar conspiracy is a complete myth that has been frequently debunked by academic researchers.[2] In 1933, General Motors and two oil companies did purchase National City Lines, which owned a number of transit companies, in order to sell their buses and diesel fuel, not to dismantle transit systems. In 1949, General Motors was convicted of conspiring to monopolize the bus market through its investments in transit companies, so it divested itself of National City.

In 1910, streetcars served 750 American cities. By 1966, all but six of these streetcar systems had been dismantled and replaced by buses.[3] General Motors and the oil companies had an interest in fewer than 25 streetcar companies at the time they converted to buses. In many cases, National City purchased the companies in the same year they stopped running streetcars, suggesting the decision had been made before National City made its investment.[4]

In short, the General Motors "conspiracy" was involved in less than 5 percent of the conversions from streetcars to buses. The other 95 percent knew something that many cities today have forgotten: bus service costs less to start, operate, and maintain; can run on schedules that are as fast or faster than light rail; and is more flexible than rail service.

Rail advocates have used the streetcar-conspiracy myth and other myths as a part of their campaign to persuade cities to build new rail transit lines. This effort has been remarkably successful: in the last 15 years alone, American cities have spent $100 billion on new rail transit lines.[5]

Since 1980, 15 U.S. urban areas that were once served exclusively by bus transit have opened new light-rail lines. Light-rail lines are also under construction in at least two other regions, and in the planning stages in several more; and several other regions have opened or are planning commuter-rail lines that use existing tracks.

Rail advocates claimed that rail transit would cost little to build and operate, attract people out of their automobiles, relieve congestion, and restore inner cities. Although most transit agencies that built these lines claim they are successful, an objective look at the evidence reveals that these benefits are just as mythical as the streetcar conspiracy.

- A recent review of rail projects found that the average cost was 40 percent higher than the estimates made when the decision was made to build it.[6]
- The Government Accountability Office notes that bus rapid transit can cost as little as 2 percent as much to start, cost less to operate, and provide faster service than light rail.[7]
- A comparison of the cost of rail transit systems with the benefits provided by those systems found that, "with the single exception of BART in the San Francisco Bay area, *every* U.S. [rail] transit system actually reduces social welfare."[8]
- The cost of rail transit is so high that many transit agencies have been forced to raise fares and/or cut back on bus service, leading to actual losses in transit ridership in such regions as Baltimore, Los Angeles, and San Jose.[9]
- Even in regions where transit ridership has increased, those increases rarely keep up with increases in driving; so in almost every new rail region, transit carried a smaller share of passenger travel after rail service opened than before rail construction began.
- The American Public Transportation Association brags that ridership on light-rail transit is growing faster than any other form of transit.[10] But this is only because agencies are offering so much more

light-rail service. The average number of trips taken per light-rail vehicle mile declined from 7.3 in 1995 to 5.2 in 2005, indicating that light rail is suffering from a serious case of diminishing returns.

- Although Denver, Portland, San Jose, and other cities often claim that light rail stimulated economic development, such developments are almost always supported by large tax subsidies.[11] At best, the developments that result from rail transit are a zero-sum game, that is, they merely transfer developments that would have taken place anyway from one part of an urban area to another.[12]

One by one, all the original justifications for building rail transit have been discredited by the evidence. In response, rail advocates and transit agencies offer two new reasons for building rail lines: energy and global warming. Rail transit, they say, uses less energy and emits less greenhouse gases per passenger mile than buses, autos, or other forms of transportation. Cities that want to prepare for an age of scarce oil or limits on greenhouse gases, they argue, should build more rail lines.

Many people accept these statements without question. A recent National Public Radio story argued that "part of the solution (to global warming) is light rail."[13] Portland, Oregon, has been named the nation's "greenest city" mainly on the strength of the supposed reduction in greenhouse gases emitted by its light-rail lines.[14]

Is this a valid argument? Assuming we are running out of oil and/or that anthropogenic global warming is a real problem, is light rail, or any form of rail transit, an appropriate response? To answer this question, we can look at the effects of existing and new rail transit lines on energy consumption and greenhouse gas emissions in the cities that have built and maintained those lines.

## Data Sources

Data needed to calculate the energy efficiency and greenhouse gas emissions of rail transit are available from a variety of federal agencies:

- The U.S. Department of Transportation's *National Transit Database* shows fuel consumption by mode for most public transit operations.[15]
- The U.S. Department of Energy's *Transportation Energy Data Book* provides factors for converting gasoline, diesel, kilowatt-hours, and other fuels into British Thermal Units.[16]
- The Energy Information Administration provides coefficients for estimating carbon dioxide ($CO_2$) emissions by energy source.[17] It also provides data on the mix of energy sources used to produce electricity in each state.[18]
- For comparison, information about auto energy efficiency is available in the *Transportation Energy Data Book*.[19] Information about specific brands of autos is available from the Environmental Protection Agency's new measure of fuel economy for 2008 automobiles.[20]

These data can be used to calculate energy use and emissions for most of the transit systems in the United States. However, there are a few limits. The *National Transit Database* only includes fuel numbers for transit lines that are directly operated by transit agencies. Agencies that contract out their operations to private companies such as Laidlaw or First Transit do not report the fuel those companies use. This means there are no results for many of the new commuter rail lines, including those in Dallas, Ft. Lauderdale, Los Angeles, San Diego, San Jose, Seattle, and the Washington, D.C., area.

Still, data are available for almost every heavy-rail system, most light-rail systems, and several commuter-rail systems, not to mention hundreds of bus systems and the handful of trolley buses, ferry systems, and other forms of transit that still operate. For each of these systems we can calculate BTUs and pounds of $CO_2$ emissions per passenger mile.

Calculations of $CO_2$ emissions by electrically powered transit are complicated by the fact that

**Now that all the original justifications for building rail transit have been discredited by the evidence, rail advocates offer two new reasons: energy and global warming.**

**On average, light rail uses as much energy per passenger mile as passenger automobiles.**

different sources of electricity are used in different regions of the country. Three-fourths of the electricity used in Washington state comes from hydroelectric dams, while all of the electricity used in Washington, D.C., comes from burning oil. The Energy Information Administration publishes an annual report showing the sources of electrical power by state.[21]

As used in this paper, *automobile* denotes four-wheeled passenger-carrying vehicles including *passenger cars* and *light trucks*. Light trucks, in turn, include pickups, sport utility vehicles, and vans.

*Light rail* includes self-powered rail transit cars that sometimes operate in their own exclusive rights of way and sometimes run in streets. *Heavy rail*, also known as subways or elevateds, always run in exclusive rights of way. *Commuter rail* usually consists of a locomotive pulling unpowered passenger cars on tracks that are often shared with freight trains. These tracks may cross streets at grade but usually do not operate in streets.

A number of rail lines that the *National Transit Database* classifies as light rail are actually *streetcars*, which tend to be smaller vehicles than light-rail cars, run on shorter routes, and run almost exclusively in streets. *Automated guideways*, sometimes called *people movers*, are self-powered vehicles that run without drivers, usually elevated above street level. *Motor buses* are powered by internal combustion engines whereas *trolley buses* are powered by electricity.

## Modal Averages

Table 1 shows the average number of BTUs and pounds of $CO_2$ per passenger mile for various modes of transit and types of automobiles. Ferries and automated guideways are far worse, on both counts, than any other form of passenger travel. Motor buses and light trucks are comparable to one another, while light rail uses the same energy as passenger cars but emits less $CO_2$.

**Table 1**
**Modal Energy Consumption and $CO_2$ Emissions per Passenger Mile**

| | BTUs | Pounds $CO_2$ |
|---|---|---|
| Ferry Boats | 10,744 | 1.73 |
| Automated Guideways | 10,661 | 1.36 |
| Light Trucks | 4,423 | 0.69 |
| Motor Buses | 4,365 | 0.71 |
| Trolley Buses | 3,923 | 0.28 |
| All Automobiles | 3,885 | 0.61 |
| Light Rail | 3,465 | 0.36 |
| Passenger Cars | 3,445 | 0.54 |
| All Transit | 3,444 | 0.47 |
| Heavy Rail | 2,600 | 0.25 |
| Commuter Rail | 2,558 | 0.29 |
| Toyota Prius | 1,659 | 0.26 |

Source: Calculations based on data in Federal Transit Administration, "Energy Consumption," *2006 Provisional National Transit Database* (Washington: U.S. Department of Transportation, 2007), tinyurl.com/3cdn6k; Stacy C. Davis and Susan W. Diegel, *Transportation Energy Data Book: Edition 26* (Oak Ridge, TN: U.S. Department of Energy, 2007), pp. B-4, B-6, Table 2.13; Energy Information Administration, "Fuel and Energy Emission Coefficients," (Washington: Department of Energy), tinyurl.com/smdrm; Energy Information Administration, *State Electricity Profiles 2006* (Washington: Department of Energy, 2007), Table 5; Environmental Protection Agency, *Model Year 2008 Fuel Economy Guide* (Washington: EPA, 2007), tinyurl.com/25y3ce.

**Table 2**
**Household Size and Average Auto Occupancy**

| | Household Size | Occupancy |
|---|---|---|
| 1969 | 3.27 | 1.90 |
| 1977 | 2.86 | 1.90 |
| 1983 | 2.73 | 1.75 |
| 1990 | 2.63 | 1.64 |
| 1995 | 2.65 | 1.59 |
| 2001 | 2.58 | 1.63 |

Source: Census Bureau, "Average Population by Household and Family: 1940 to Present" (Washington, 2004), tinyurl.com/2hpgbx; and Pat S. Hu, *Summary of Travel Trends: 2001 National Household Travel Survey* (Washington, US DOT, 2004), table 15.

The Toyota Prius, the most fuel-efficient auto sold in the United States, is also shown as an example of the potential for energy-efficient autos.[22] The Prius uses less energy than other forms of travel, but generates about the same $CO_2$ as heavy rail and commuter rail.

Emissions from electrically powered transit depend on local sources of electricity. Massachusetts and Ohio, for example, rely heavily on fossil fuels for electrical power, so trolley buses in those states emit more greenhouse gases than diesel buses. But Washington and California rely more heavily on hydroelectric power, so trolley buses in those states emit less greenhouse gases than diesel buses.

All of these numbers are very sensitive to load factors. Because the vehicles themselves tend to weigh far more than the passengers being carried, doubling the number of people on board any vehicle will cut the energy consumption and emissions per passenger almost in half. Using estimates from the *2001 National Household Travel Survey*, Table 1 assumes that passenger autos carry an average of 1.57 people, while light trucks carry an average of 1.73 people.[23] Transit loads are from the *National Transit Database* (passenger miles divided by vehicle revenue miles).[24]

One obvious way to reduce energy consumption and emissions is to increase vehicle occupancies. Increasing auto occupancies is easier said than done, however. As Table 2 shows, average auto occupancies roughly equal average household size minus one. Efforts to increase occupancies with carpool lanes have mostly failed. Indeed, most carpools are really "fampools," that is, family members traveling together to work or other destinations.

Transit loads are easier to manipulate by directing transit service to areas where demand is high and avoiding or providing smaller vehicles in areas where demand is low. Most transit agencies fail to do this for political reasons. Since transit agencies rely heavily on tax dollars, they try to provide at least some service to all taxpayers in a region. Because a large share of their capital costs is funded by federal grants, they also tend to buy buses that are larger than they really need. The result is that they often run buses that are nearly empty.

## Modal Trends

Not only are passenger autos competitive (at least in terms of energy efficiency) with public transit, autos are becoming more energy efficient each year, whereas transit's efficiency is stagnant or declining. The energy efficiency of passenger cars per vehicle mile has grown by an average of 1.5 percent per year, and when fuel prices have been high, it has grown by as much as 3.0 percent per year. Since auto occupancies have been declining, efficiencies per passenger mile have only grown at an average

**Automobiles are becoming more energy efficient each year, whereas transit's efficiency is stagnant or declining.**

**Automobiles will continue to become more energy efficient by 2 percent per year, which means that new rail transit lines must be more efficient than future autos to achieve any savings at all.**

of 0.9 percent per year; but they have grown as fast as 2.5 percent per year when fuel prices were highest.[25]

The fuel efficiencies of light trucks have grown faster than cars, partly because light truck occupancies have increased. In 1970, the vast majority of light trucks were pickups. Today, most are vans or sport utility vehicles, which tend to have much higher occupancies than pickups.[26]

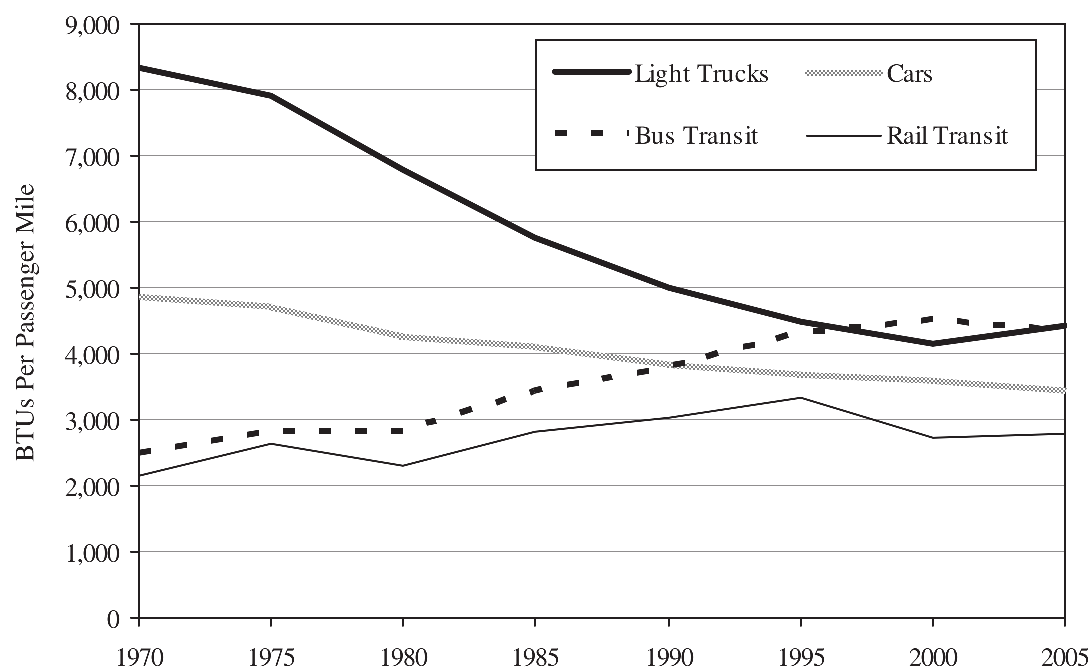
These trends will be accelerated by the Energy Independence and Security Act of 2007, which requires that corporate average fuel economy (CAFE) increases from 27.5 miles per gallon today to 35 miles per gallon by 2020. The law also requires that production of biofuels (which produce only one-third the net greenhouse gas emissions of fossil fuels) increase from 4 billion gallons today to 36 billion by 2022.[27]

The net effect of this law will be to increase fuel economies by close to 2 percent per year. By 2020, the average automobile on the road will consume little more than 3,000 BTUs per passenger mile. By 2035, even if new-car efficiencies do not improve after 2020, the average auto will consume just 2,500 BTUs per passenger mile.[28]

Projections of the energy efficiency of rail transit must take into account the growing energy efficiency of automobiles. A proposed light-rail line that promises to save energy not only needs to be more efficient than today's autos, it must be more efficient than future autos. Since rail lines typically take 10 years to plan and construct, and have an operational life (before they need reconstruction and rehabilitation) of 30 to 40 years, they would have to be more efficient than the average auto 25 to 30 years from now to achieve any savings at all.

Suppose a light-rail line is projected to open in 2015 and operate until 2055. If the average auto consumed 3,885 BTUs per passenger mile in 2005, and auto energy efficiency is growing at 2.7 percent per year, then when the rail line opens, autos will be using less than 3,400 BTUs per passenger mile. At the light-rail line's mid-life in 2035, autos will

**Figure 1**
**Energy Intensity of Passenger Transport**




Source: Davis and Diegel, *Transportation Energy Data Book*, Tables 2.13 and 2.14.

consume only 2,500 BTUs per passenger mile. Since only one light-rail line operating today consumes significantly less than that, new light-rail lines are not likely to achieve any savings.

Production of carbon dioxide ($CO_2$) by petroleum-fueled motor vehicles is almost exactly proportional to their energy efficiency. $CO_2$ emissions from motor vehicles can be reduced, however, by using biofuels, which offset the $CO_2$ emissions by obtaining energy from plants taking carbon out of the atmosphere. The biofuel requirement in the 2007 Energy Act means that greenhouse gas emissions per passenger mile will decline even faster than fuel consumption.

In contrast to autos, fuel economies for bus transit have declined in almost every five-year period since 1970. This is partly because transit agencies have purchased larger vehicles and increasingly supplied them with air conditioning and other energy-intensive features, and partly because the number of people riding the average bus has declined. In 1982 (the earliest year for which data are available), the average number of bus occupants (passenger miles divided by vehicle revenue miles) was 13.8; by 2006, it was only 10.7.[29]

Rail transit's energy intensity has been flat or trending upwards.[30] But the New York urban area heavily skews rail numbers. New York provided more than 65 percent of rail transit passenger miles in 1980 and even today accounts for 55 percent of rail passenger miles.[31] New York rail ridership dropped dramatically in the 1980s, bottoming out in 1993. Since then, it has recovered. The trend for rail in Figure 1 largely reflects what happened in New York and says little about the energy efficiency of rail transit in other regions.

In general, the trends for $CO_2$ emissions for bus and rail transit probably roughly follow the trends for energy efficiency. Detailed calculations are complicated because so many different fuels are used to power these modes, and data are not available before 1982. Most buses rely on diesel fuel, but many use gasoline, some use compressed natural gas or other fuels, and a few (separately classified as "trolley buses") are electric. Some rail transit is diesel powered, but most rail transit is electrically powered. The sources of that electricity include some greenhouse gas emitters, such as coal and oil, and some non-emitters, such as nuclear and hydro.

## Urban Area Modal Data

Table 3 lists the energy efficiency and $CO_2$ emissions for most of the nation's light-rail, heavy-rail, and commuter-rail lines in 2006. Also listed are streetcars, ferryboats, and trolley buses, each of which is being considered by some cities. For good measure, the table also includes automated guideways and cable cars, even though these are not being seriously considered by any major cities.

***Commuter rail.*** Two commuter-rail systems —New Jersey Transit and the Northern Indiana Commuter District—are the only transit systems that use less energy per passenger mile than a Toyota Prius. All other commuter-rail lines, except for the SEPTA system in Philadelphia, use less energy than the average passenger auto.

The commuter-rail systems shown in Table 3 are electrically powered, while most of the commuter-rail systems for which there are no data are diesel-powered. So the missing systems may produce more greenhouse gases per passenger mile than the systems shown in the table.

***Heavy rail.*** As Figure 2 shows, most heavy-rail systems are less energy efficient than an average passenger car, and none are more energy efficient than a Toyota Prius. As Table 3 shows, two of them—New York subways and San Francisco BART—emit less $CO_2$ than a Prius, but several emit more $CO_2$ than the average passenger car.

***Light rail.*** Most light-rail systems use as much or more energy per passenger mile as the average passenger car, several are worse than the average light truck, and none is as efficient as a Prius (see Figure 3). Three emit less greenhouse gases than a Prius, but several emit more greenhouse gases than light trucks (see Table 3).

**Most light- and heavy-rail lines are less energy efficient than the average passenger car, and none are as efficient as a Prius.**

**Table 3**
**Transit Line Energy Consumption and $CO_2$ Emissions per Passenger Mile**

| Urban Area | BTUs | Pounds $CO_2$ |
|---|---|---|
| | *Commuter Rail* | |
| Chicago (NW IN) | 1,587 | 0.33 |
| Newark (NJT) | 1,599 | 0.19 |
| Boston | 2,209 | 0.36 |
| New York (LIRR) | 2,681 | 0.24 |
| Chicago (RTA) | 2,693 | 0.40 |
| New York (Metro-North) | 3,155 | 0.28 |
| Philadelphia | 4,168 | 0.53 |
| | *Heavy Rail* | |
| Atlanta | 1,983 | 0.29 |
| New York (MTA) | 2,149 | 0.16 |
| San Francisco (BART) | 2,299 | 0.14 |
| New York (PATH) | 2,953 | 0.20 |
| Washington | 3,084 | 0.62 |
| Chicago | 3,597 | 0.37 |
| Boston | 3,631 | 0.44 |
| Baltimore | 3,736 | 0.50 |
| Philadelphia (SEPTA) | 3,745 | 0.48 |
| Los Angeles | 4,233 | 0.26 |
| Philadelphia (PATH) | 5,077 | 0.35 |
| Cleveland | 5,494 | 1.02 |
| Miami | 6,756 | 0.89 |
| Staten Island | 8,039 | 0.60 |
| | *Light Rail* | |
| San Diego | 2,102 | 0.13 |
| Boston | 2,473 | 0.30 |
| Portland | 2,482 | 0.08 |
| Minneapolis | 2,498 | 0.35 |
| St. Louis | 2,613 | 0.48 |
| Salt Lake City | 2,830 | 0.56 |
| Houston | 2,849 | 0.39 |
| Los Angeles | 2,884 | 0.18 |
| Denver | 4,400 | 0.78 |
| Dallas | 4,466 | 0.60 |
| San Francisco | 4,509 | 0.27 |
| Newark | 4,564 | 0.31 |
| Sacramento | 4,821 | 0.29 |
| Philadelphia | 5,459 | 0.69 |
| Cleveland | 5,585 | 1.03 |
| Buffalo | 5,774 | 0.43 |
| San Jose | 6,174 | 0.38 |
| Baltimore | 8,128 | 1.09 |
| Pittsburgh | 9,265 | 1.18 |

| Urban Area | BTUs | Pounds $CO_2$ |
|---|---|---|
| | *Streetcars/Vintage Trolleys* | |
| New Orleans | 3,540 | 0.40 |
| Tacoma | 4,396 | 0.09 |
| Charlotte | 5,438 | 0.71 |
| Tampa | 7,941 | 1.04 |
| Little Rock | 12,948 | 1.54 |
| Memphis | 17,521 | 2.42 |
| Kenosha | 32,910 | 4.94 |
| Galveston | 34,325 | 5.58 |
| | *Trolley Bus* | |
| San Francisco | 3,341 | 0.21 |
| Seattle | 3,912 | 0.08 |
| Dayton | 6,377 | 1.12 |
| Boston | 7,589 | 0.88 |
| | *Ferry Boat* | |
| New York | 4,457 | 0.72 |
| San Francisco | 10,173 | 1.65 |
| Portland | 11,464 | 1.86 |
| Seattle | 13,118 | 2.13 |
| Savannah | 38,864 | 6.31 |
| San Juan | 60,582 | 9.84 |
| New Orleans | 71,784 | 11.66 |
| | *Automated Guideway* | |
| Miami | 7,649 | 1.00 |
| Detroit | 15,058 | 2.11 |
| Jacksonville | 54,054 | 7.09 |
| | *Cable Car* | |
| San Francisco | 4,629 | 0.28 |

Source: Calculations based on data from Federal Transit Administration, "Energy Consumption," *2006 Provisional National Transit Database* (Washington: U.S. Department of Transportation, 2007), tinyurl.com/3cdn6k; Stacy C. Davis and Susan W. Diegel, *Transportation Energy Data Book: Edition 26* (Oak Ridge, TN: U.S. Department of Energy, 2007), pp. B-4, B-6; Energy Information Administration, "Fuel and Energy Emission Coefficients," (Washington: Department of Energy), tinyurl.com/smdrm; Energy Information Administration, *State Electricity Profiles 2006* (Washington: Department of Energy, 2007), table 5.
Note: Salt Lake City data adjusted for ridership overcounts revealed by local transit agency.

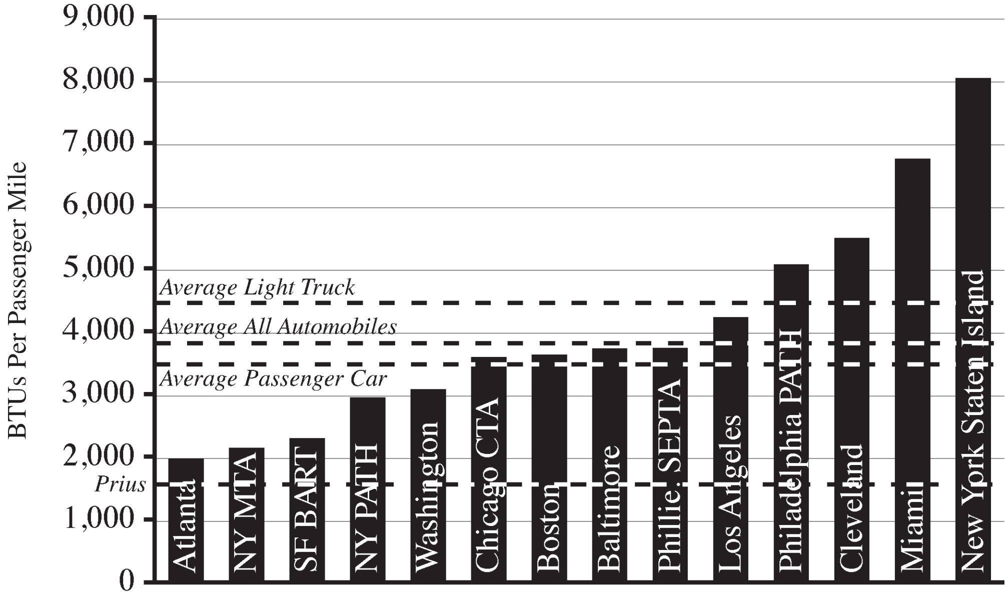
***Streetcars.*** Streetcars and vintage trolleys consume lots of energy and, for the most part, emit lots of greenhouse gases per passenger mile. The poor performance of these systems results from low passenger loads, as many carry average loads of just two to six riders.

***Trolley Buses.*** Trolley buses in Seattle and San Francisco use somewhat less energy than buses, probably because they are concentrated in the inner cities while most bus lines serve many suburban areas. In regions where much if not most electricity comes from hydro or other non-fossil-fuel sources, trolley buses can reduce greenhouse gas emissions, but otherwise they are not effective.

***Ferryboats.*** If saving energy and reducing greenhouse gases are the goals, ferryboats are a very poor choice of transit.

**Streetcars and ferryboats tend to use the most energy and generate the most greenhouse gases per passenger mile of any form of transit.**

**Figure 2**
**Heavy-Rail Energy Consumption**




Source: Calculations based on data in Federal Transit Administration, "Energy Consumption," *2006 Provisional National Transit Database* (Washington: U.S. Department of Transportation, 2007), tinyurl.com/3cdn6k; Stacy C. Davis and Susan W. Diegel, *Transportation Energy Data Book: Edition 26* (Oak Ridge, TN: U.S. Department of Energy, 2007), pp. B-4, B-6, Table 2.13; Energy Information Administration, "Fuel and Energy Emission Coefficients," (Washington: Department of Energy), tinyurl.com/smdrm; Energy Information Administration, *State Electricity Profiles 2006* (Washington: Department of Energy, 2007), table 5; Environmental Protection Agency, *Model Year 2008 Fuel Economy Guide* (Washington: EPA, 2007), tinyurl.com/25y3ce.

***Automated Guideways.*** The "people movers" in Florida and Detroit have mostly been disappointments. One in Tampa was even torn out because ridership was so low. Not surprisingly, they require large amounts of energy per passenger mile.

***Cable Cars.*** The San Francisco cable cars use a lot of energy. But California gets nearly half its electricity from renewable sources that emit little or no $CO_2$, so they are relatively greenhouse friendly.

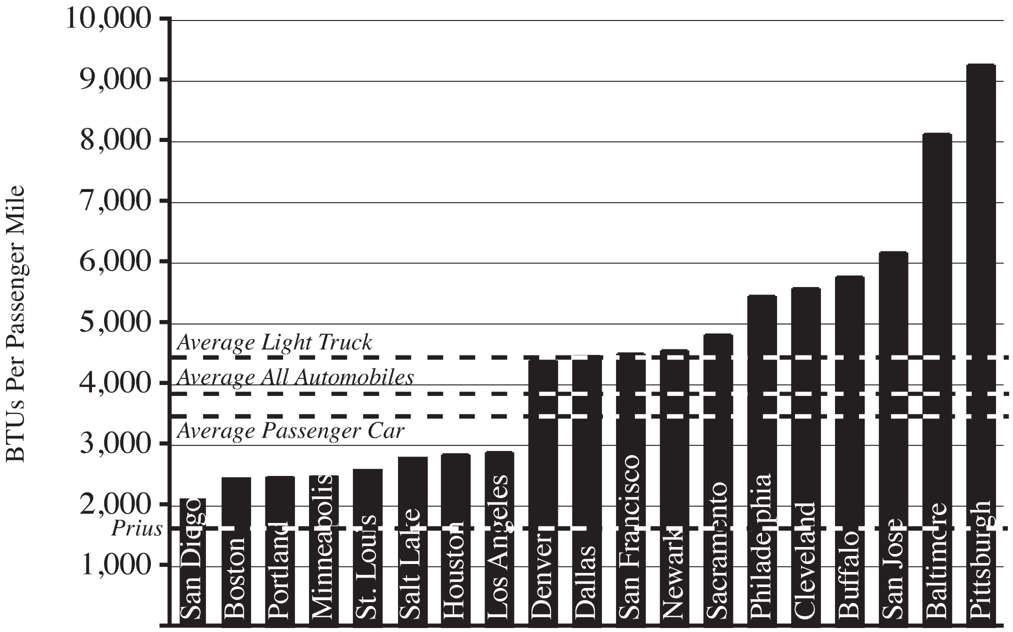
National Transit Database numbers for Salt Lake City indicate that it has an extraordinarily efficient light-rail line, equal in energy performance to the San Diego line. However, the Utah Transit Authority recently revealed that it has systematically overestimated light-rail ridership by 20 percent or more for several years. The agency installed automated passenger counters in all its rail vehicles, whereas previously it had relied on a sampling system. The new counters reveal light rail carries about 22 percent fewer riders than the transit authority had previously reported.[32] The numbers in Table 3 have been adjusted to account for this overcount.

Only a handful of rail systems are more environmentally friendly than a Toyota Prius, and most use more energy per passenger mile than the average automobile. Steel wheels on steel rails require far less friction to turn than rubber tires on pavement. So why do rail systems have such mediocre performances?

One reason is that, for the safety and comfort of passengers, rail cars tend to be heavier per passenger than buses. A typical light-rail car, for example, weighs about 100,000 pounds compared with 27,000 pounds for a typical bus. Light-rail loads and capacities are around two-and-one-half times those of buses, so light-rail cars weigh around 60 percent more per passenger.[33]

**Rail systems do poorly partly because rail cars weigh around 60 percent more, per passenger, than buses.**

**Figure 3**
**Light-Rail Energy Consumption**




Source: Calculations based on data in Federal Transit Administration, "Energy Consumption," 2006 Provisional National Transit Database (Washington: U.S. Department of Transportation, 2007), tinyurl.com/3cdn6k; Stacy C. Davis and Susan W. Diegel, Transportation Energy Data Book: Edition 26 (Oak Ridge, TN: U.S. Department of Energy, 2007), pp. B-4, B-6, Table 2.13; Energy Information Administration, "Fuel and Energy Emission Coefficients," (Washington: Department of Energy), tinyurl.com/smdrm; Energy Information Administration, State Electricity Profiles 2006 (Washington: Department of Energy, 2007), table 5; Environmental Protection Agency, Model Year 2008 Fuel Economy Guide (Washington: EPA, 2007), tinyurl.com/25y3ce.

A second problem is that electrically powered systems suffer significant losses in generation and transmission. A kilowatt-hour provides users with about 3,400 BTUs of energy. But the electricity producer must use more than 10,300 BTUs to deliver that kilowatt-hour to the user.[34] Trolley buses in Boston, Dayton, and Seattle, for example, consume more energy per passenger mile than diesel buses in those same cities even though the trolley buses carry the same or greater loads.[35]

A third problem is that rail lines cost a lot to build, so they are largely limited to major corridor routes. To justify the large investment, transit agencies operate light- and heavy-rail lines at greater frequencies than buses. Where buses can run frequent service in busy corridors and then diverge into various neighborhoods at the ends of the corridors, trains are confined to the rails. The result is that the train cars are substantially empty at the ends of their corridors and during much of the day.

All of these factors counteract rail's inherent efficiency advantage. The result is that rails are energy efficient only in extremely high-use corridors, and electrically powered rail lines are greenhouse friendly only in regions that use alternatives to fossil fuels to generate half or more of their electricity.

Even rail lines that use significantly less energy than autos will not save much energy unless they attract a significant number of people who would otherwise drive their cars. Table 4 shows that no region with rail transit has been able to persuade more than 0.5 percent of travelers to switch from cars to transit in the past 20 years. Transit's share of travel has actually declined since rail service began (or since 1985 for regions that had rail service before 1985) in 14 out of 25 regions with rail transit.

**Electrically powered transit loses two-thirds of its energy in electrical generation and transmission.**

**Table 4**
**Transit's Share of Motorized Passenger Travel (percent)**

| | 1985 | 1990 | 1995 | 2000 | 2005 | Rail Began |
|---|---|---|---|---|---|---|
| Atlanta | 1.9 | 1.8 | 1.3 | 1.4 | 1.1 | 1979 |
| Baltimore | 1.9 | 1.8 | 1.5 | 1.6 | 1.4 | 1983 |
| Boston | 2.6 | 2.8 | 3.0 | 3.4 | 3.1 | 1888 |
| Buffalo | 1.2 | 0.9 | 0.8 | 0.7 | 0.6 | 1986 |
| Chicago | 5.7 | 4.8 | 3.6 | 3.7 | 3.7 | 1892 |
| Cleveland | 2.3 | 1.5 | 1.2 | 1.3 | 1.3 | 1884 |
| Dallas–Ft. Worth | 0.8 | 0.6 | 0.5 | 0.6 | 0.6 | 1996 |
| Denver | 1.4 | 1.3 | 1.2 | 1.3 | 1.4 | 1994 |
| Houston | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 2004 |
| Los Angeles | 1.9 | 1.4 | 1.3 | 1.4 | 1.8 | 1988 |
| Miami–Ft. Lauderdale | 1.2 | 1.1 | 1.1 | 1.0 | 1.0 | 1984 |
| Minneapolis–St. Paul | 1.4 | 1.1 | 0.8 | 1.0 | 1.0 | 2004 |
| New Orleans | 3.1 | 2.9 | 2.4 | 1.9 | 1.4 | 1892 |
| New York | 12.7 | 10.4 | 9.9 | 10.4 | 9.6 | 1905 |
| Philadelphia | 3.4 | 3.3 | 2.5 | 2.6 | 2.5 | 1890 |
| Pittsburgh | 2.2 | 2.1 | 1.5 | 1.5 | 1.3 | 1890 |
| Portland | 2.1 | 1.8 | 2.0 | 2.1 | 2.2 | 1986 |
| Sacramento | 0.9 | 0.7 | 0.7 | 0.9 | 0.7 | 1987 |
| Salt Lake City | 1.1 | 1.7 | 1.1 | 1.0 | 1.2 | 1999 |
| San Diego | 1.1 | 1.2 | 1.0 | 1.4 | 1.1 | 1981 |
| San Francisco–Oakland | 5.3 | 4.3 | 3.9 | 4.2 | 4.1 | 1972 |
| San Jose | 0.9 | 1.0 | 0.9 | 1.1 | 0.9 | 1988 |
| Seattle | 1.8 | 1.5 | 1.4 | 1.6 | 1.9 | 2000 |
| St. Louis | 1.0 | 0.7 | 0.6 | 0.8 | 0.7 | 1994 |
| Washington | 3.9 | 4.4 | 3.9 | 4.0 | 4.0 | 1976 |

Sources: Transit passenger miles from Federal Transportation Administration, *National Transit Database*, compared with motor vehicle miles (multiplied by 1.6 to get passenger miles) from Federal Highway Administration, *Highway Statistics* (years indicated in table).

**Rather than attract people out of their cars, transit's share of commuting has declined in 20 out of 25 rail regions.**

The same tale of woe is told by commuting data (see Table 5). Twenty out of 25 rail regions saw a decline in transit's market share of commuters since they began rail service (or 1970, in the case of regions that have had rail service since before 1970). Among the few that increased, Seattle's increase was the greatest, with transit's share rising from 7.1 percent in 1990 to 8.1 percent in 2006. Very little of that increase, however, was due to the region's trivial rail transit projects, which carried less than 2 percent of the region's transit trips in 2006.

Transit's loss of market share in most rail cities is not just a case of bad luck. Rail transit agencies must go heavily in debt to cover the high cost of building rail transit lines, and once that debt is paid off they have to go in debt again to reconstruct and rehabilitate worn out rail lines. To keep its rail system running, for example, Boston has incurred a $5 billion debt and must dedicate one-third of its operating budget just to pay the interest on that debt.[36]

Such indebtedness—which is not needed to operate a bus system—leaves transit riders vulnerable to economic downturns that reduce the tax revenues transit agencies rely on to both repay their debts and operate their sys-

**Table 5**
**Transit's Share of Commuting (percent)**

| | 1970 | 1980 | 1990 | 2000 | 2006 | Rail Began |
|---|---|---|---|---|---|---|
| Atlanta | 10.4 | 9.1 | 5.9 | 4.1 | 4.4 | 1979 |
| Baltimore | 16.9 | 12.3 | 9.3 | 7.4 | 8.1 | 1983 |
| Boston | 18.2 | 13.5 | 12.7 | 12.5 | 12.3 | 1888 |
| Buffalo | 12.3 | 16.4 | 5.5 | 4.0 | 4.9 | 1986 |
| Chicago | 24.4 | 18.7 | 15.8 | 12.6 | 12.2 | 1892 |
| Cleveland | 14.0 | 11.5 | 6.8 | 5.0 | 4.6 | 1884 |
| Dallas–Ft. Worth | 5.7 | 4.0 | 2.7 | 2.2 | 2.1 | 1996 |
| Denver-Boulder | 4.6 | 6.6 | 4.8 | 5.1 | 5.3 | 1994 |
| Houston | 6.0 | 3.5 | 4.5 | 3.8 | 3.2 | 2004 |
| Los Angeles | 4.8 | 5.9 | 5.6 | 6.0 | 6.3 | 1988 |
| Miami–Ft. Lauderdale | 6.2 | 4.3 | 3.7 | 3.3 | 4.0 | 1984 |
| Minneapolis–St. Paul | 9.5 | 10.0 | 6.2 | 5.5 | 5.1 | 2004 |
| New Orleans | 21.5 | 11.5 | 8.3 | 7.1 | 2.9 | 1892 |
| New York | 39.0 | 30.7 | 29.3 | 28.9 | 30.8 | 1905 |
| Philadelphia | 23.0 | 15.1 | 12.4 | 10.1 | 9.8 | 1890 |
| Pittsburgh | 17.7 | 13.8 | 10.2 | 8.1 | 8.0 | 1890 |
| Portland | 7.0 | 9.8 | 6.7 | 7.7 | 7.6 | 1986 |
| Sacramento | 2.7 | 4.1 | 2.8 | 2.9 | 2.9 | 1987 |
| Salt Lake City | 2.3 | 5.5 | 3.5 | 3.6 | 4.2 | 1999 |
| San Diego | 4.8 | 3.5 | 3.5 | 3.6 | 3.3 | 1981 |
| San Francisco–Oakland | 16.0 | 16.8 | 14.5 | 14.3 | 13.1 | 1972 |
| San Jose | 2.4 | 3.1 | 3.1 | 3.6 | 3.6 | 1988 |
| Seattle | 6.6 | 9.1 | 7.1 | 7.9 | 8.1 | 2000 |
| St. Louis | 9.2 | 6.9 | 3.5 | 2.9 | 3.1 | 1994 |
| Washington | 17.6 | 16.7 | 15.6 | 13.7 | 16.9 | 1976 |

Sources: Census Bureau, *Decennial Census, 1970 through 2000*, and *American Community Survey for 2006* (Washington: Census Bureau).

tems. When tax revenues decline, debt holders will not accept lower payments, so transit agencies must make much larger cuts to their transit systems than if they had no debt.

San Jose, for example, went into debt building new light-rail lines in the 1990s. When the 2001 recession hit, it was forced to cut transit service by nearly 20 percent and lost more than a third of its transit riders.[37]

So, even though some systems report that their rail lines generate less greenhouse gases than automobiles, they are not saving energy if they are losing market share to the auto. At best, agencies might brag that rail transit saves energy by carrying people who would otherwise ride an energy-intensive and $CO_2$-emitting bus. But, as the next section will show, new rail transit lines do not reduce energy use by buses.

## Urban Transit Network Data

Table 6 lists the average energy efficiency and $CO_2$ outputs for all transit agencies for which data are available in 50 major urban areas in the country. A few regions are not listed because most or all of their transit systems are contracted out and so representative data are not available.

**Unlike bus transit, the high cost of rail transit forces transit agencies into debt that leaves them especially vulnerable to recessions.**

**Transit systems in Baltimore, Dallas, Miami, San Jose, and Sacramento are less environmentally friendly than SUVs.**

**Table 6**
**Urban Area Transit Energy Consumption and CO2 Emissions per Passenger Mile**

| Urban Area | BTUs | Pounds CO2 | Urban Area | BTUs | Pounds CO2 |
|---|---|---|---|---|---|
| New York | 2,639 | 0.29 | Columbus | 4,643 | 0.50 |
| Atlanta | 2,865 | 0.45 | Cleveland | 4,703 | 0.79 |
| San Francisco–Oakland | 3,003 | 0.30 | Austin | 4,985 | 0.80 |
| Portland | 3,008 | 0.36 | Miami–Ft. Lauderdale | 5,037 | 0.76 |
| Boston | 3,201 | 0.45 | Indianapolis | 5,059 | 0.82 |
| Chicago | 3,357 | 0.46 | Tampa–St. Petersburg | 5,218 | 0.84 |
| Minneapolis–St. Paul | 3,722 | 0.56 | San Antonio | 5,351 | 0.84 |
| Houston | 3,528 | 0.57 | Pittsburgh | 5,357 | 0.82 |
| Denver | 3,596 | 0.59 | Dallas–Ft. Worth | 5,414 | 0.85 |
| Washington | 3,646 | 0.63 | Memphis | 5,502 | 0.87 |
| Orlando | 3,670 | 0.59 | Louisville | 5,521 | 0.89 |
| Hartford | 3,670 | 0.59 | San Jose | 5,549 | 0.74 |
| Los Angeles | 3,674 | 0.56 | Buffalo | 5,602 | 0.81 |
| Salt Lake City | 3,837 | 0.66 | Sacramento | 5,613 | 0.69 |
| San Diego | 3,893 | 0.54 | Seattle | 5,805 | 0.91 |
| Cincinnati | 3,938 | 0.48 | Kansas City | 6,106 | 0.97 |
| Detroit | 3,998 | 0.64 | Riverside–San Bern. | 6,121 | 1.11 |
| Providence | 4,076 | 0.66 | Richmond | 6,193 | 1.00 |
| Norfolk | 4,133 | 0.66 | Tucson | 6,275 | 1.00 |
| Philadelphia | 4,305 | 0.57 | Jacksonville | 6,278 | 1.00 |
| St. Louis | 4,345 | 0.74 | Dayton | 6,379 | 1.05 |
| Charlotte | 4,488 | 0.72 | Oklahoma City | 6,626 | 1.07 |
| Baltimore | 4,497 | 0.67 | Norwalk | 7,243 | 1.17 |
| Milwaukee | 4,572 | 0.74 | New Orleans | 8,674 | 1.40 |
| Nashville | 4,596 | 0.74 | | | |

Source: Calculations based on data from Federal Transit Administration, "Energy Consumption," *2006 Provisional National Transit Database* (Washington: U.S. Department of Transportation, 2007), tinyurl.com/3cdn6k; Stacy C. Davis and Susan W. Diegel, *Transportation Energy Data Book: Edition 26* (Oak Ridge, TN: U.S. Department of Energy, 2007), pp. B-4, B-6; Energy Information Administration, "Fuel and Energy Emission Coefficients," (Washington: Department of Energy), tinyurl.com/smdrm; Energy Information Administration, *State Electricity Profiles 2006* (Washington: Department of Energy, 2007), table 5.

The most energy-efficient transit network is in New York City. New York's transit network is efficient not just because it has rail transit, but because its buses average 60 percent greater loads than the rest of the country (more than 17 passengers versus fewer than 11).

Other than the top six or seven systems, U.S. transit networks use as much or more energy and emit as much or more $CO_2$ per passenger mile as the average passenger car. Many regions with rail transit, including Baltimore, Dallas, Miami, San Jose, and Sacramento, are less environmentally friendly than light trucks.

One reason why many rail regions do so poorly is that new rail lines cannibalize bus systems by taking their most popular—and therefore most energy-efficient—routes. Moreover, after opening a new rail line, transit agencies typically offer their customers more bus service, not less, as corridor bus routes are turned into feeder buses for the rail corridor. Since many people who have access to autos will drive to the rail stations, those feeder buses tend to operate with much smaller average loads than the corridor buses they replaced.

Many regions that build new rail transit lines end up using more fuel on buses carrying smaller average loads than before they built those lines. For example, in 1991, before St. Louis built its first light-rail line, St. Louis buses averaged more than 10 riders and consumed 4,600 BTUs per passenger mile. In 1995, after opening the light-rail line, average bus loads declined to fewer than 7 riders and energy consumption increased to 5,300 BTUs per passenger mile. $CO_2$ emissions also climbed from 0.75 pounds to 0.88 pounds per passenger mile.[38]

Other cities experienced similar declines in energy efficiencies after opening light-rail lines. Sacramento's bus loads, for example, declined from around 14 before the region's first light-rail line opened to under 10 afterwards. Overall energy consumption thus increased from around 3,000 to 4,300 BTUs per passenger mile while $CO_2$ emissions increased from 0.48 pounds to 0.58 pounds per passenger mile.[39] By 2004, Sacramento had opened a new light-rail line, but bus loads fell below 8 while overall energy consumption and $CO_2$ emissions grew to nearly 4,600 BTUs and 0.64 pounds per passenger mile.[40]

Similarly, Houston's light-rail line boosted energy consumption and $CO_2$ emissions per passenger mile by 8 to 10 percent.[41] Portland's eastside light-rail line, which opened in 1986, increased energy use and $CO_2$ production by 5 to 13 percent per passenger mile.[42] Its westside line, opened in 1998, increased energy use and $CO_2$ production by 7 to 11 percent per passenger mile.[43]

Not every transit system suffers a decline in energy efficiency after opening a rail line. Before opening the Hiawatha light-rail line in 2004, the Twin Cities' transit system used about 4,000 BTUs and emitted about 0.65 pounds of $CO_2$ per passenger mile. The light rail improved the 2006 systemwide average to 3,722 BTUs and 0.56 pounds of $CO_2$ per passenger mile.[44] But as the next section suggests, this small savings probably does not make up for the huge energy and $CO_2$ cost of building the line.

## Construction

Even if a new rail line could save energy or reduce greenhouse gases compared with buses or autos, the energy costs and $CO_2$ emissions from constructing rail lines are huge and may never be recovered by the savings. Rail transit requires significant amounts of steel and concrete, for example, the production of both of which is energy intensive and emits large volumes of $CO_2$.

The environmental impact statement for Portland's North Interstate light rail estimated that the line would save about 23 billion BTUs per year but that construction would cost 3.9 trillion BTUs.[45] Thus, it would take 172 years for the savings to repay the construction cost. In fact, long before 172 years, automobiles are likely to be so energy efficient that light rail will offer no savings at all.

Similarly, the North Link light-rail line in Seattle is estimated to save about 346 billion BTUs of energy in 2015, declining to 200 billion in 2030.[46] Construction is estimated to require 17.4 trillion BTUs.[47] If the savings remains constant at 200 billion BTUs after 2030, the savings will not repay the cost until 2095. The Federal Transit Administration says that it is satisfied with this savings, because "the light rail project is expected to have about a 100 year life."[48]

In reality, rail projects have an expected lifespan of only about 30 to 40 years, after which most of the rail line must be substantially rebuilt or replaced. Washington's Metrorail needs $12.2 billion to reconstruct and rehabilitate its rail system over the next decade, none of which is funded—and the oldest parts of the system are about 30 years old.[49] The San Francisco Bay Area Rapid Transit District, which is slightly older than Washington's Metrorail, needs $11 billion for rehabilitation, only half of which is funded.[50] No matter where the money comes from, such reconstruction will require lots of energy and emit lots of $CO_2$, all of which must be counted against any operational savings that the systems claim to provide.

These examples show that any claims that rail transit will reduce energy consumption

**Even if rail operations did save energy, it could take hundreds of years for that savings to repay the energy cost of constructing rail transit.**

**Behavioral solutions to toxic air pollution have failed miserably, so it is no surprise that behavioral solutions to greenhouse gases are also failing.**

must be met with skepticism unless they are accompanied by evidence that the operational savings will quickly repay the construction cost. Transit agencies are often reluctant to provide that evidence even when they are required to do so by law. In the environmental impact statement for Dallas' Southeast Corridor light-rail line, the chapter on environmental consequences, for example, never once mentions the words "energy," "greenhouse," or "carbon dioxide," much less estimates the energy or $CO_2$ costs of constructing the line.[51]

Highway construction also uses energy and emits $CO_2$, but each mile of urban highway typically carries far more passenger miles and freight ton miles of travel than a mile of rail transit line. In 2005, for example, the average mile of U.S. light-rail line moved only 15 percent as many passenger miles as the average lane mile of urban freeway in rail regions.[52] Highways also move millions of tons of freight that can share the cost of construction. This means the energy and $CO_2$ costs of highway construction, per passenger mile or ton mile, are far lower than for rail transit construction.

## Alternatives to Rail Transit

Since the 1960s, when Americans became alarmed about toxic air pollution, we have used two very different techniques to reduce the pollution generated by automobiles. First, we applied *technical solutions*, such as increasing traffic speeds (because cars pollute more at slower speeds) and reducing tailpipe emissions. Second, we tried *behavioral solutions* aimed at getting people to drive less.

Technical solutions have been fantastically successful. Americans drive four times as many miles as they did four decades ago, yet total automotive air pollution has been reduced by more than 50 percent.[53] New cars on the road typically pollute less than 5 percent as much as cars made in 1970, and some pollute less than 1 percent as much. Because new cars are getting cleaner every year, the air pollution problem is rapidly disappearing.[54]

In contrast, the behavioral solutions have failed miserably. Per capita driving in urban areas has more than doubled since the 1970s, and no city has managed to reduce per capita driving by even 1 percent except for short periods of time when gas prices were high. Americans respond to high fuel prices with a short-term reduction in driving, but their long-term response is to buy more fuel-efficient cars and then continue to drive more each year.

Despite the failure of behavioral solutions in the past, history is repeating itself today with cities planning rail transit lines, high-density housing projects, mixed-use developments, and other techniques aimed at changing people's travel behavior in order to reduce energy use and greenhouse gas emissions. Once again, the reality is that technical solutions cost less and do more to address these issues, while there is little evidence that the behavioral solutions will have any measurable effect at all.

Construction of new rail lines, or reconstruction of existing ones, is very expensive in dollars, energy, and greenhouse gas emissions; yet the most successful lines have attracted only a tiny percentage of motorists out of their automobiles. Even the best rail transit lines provide only small energy and greenhouse benefits relative to the most efficient automobiles. And most rail transit lines in the United States actually consume more energy per passenger mile than the average passenger car.

Rail transit may use less energy, per passenger mile, than buses. But the introduction of rail transit rarely leads to a reduction in bus operations. Instead, buses that once followed the rail corridors are converted to feeder bus routes. So the incremental effect of rail transit on a transit system's overall energy use can often be to increase consumption per passenger mile.

Transit officials and other urban leaders who have a genuine desire to reduce energy usage and greenhouse gas emissions from their regions should consider alternatives that are far more cost effective at achieving these goals than building rail transit. Four potential alternatives are these:

- Promoting alternative transit fuels and technologies;
- Increasing average bus loads;
- Reducing fuels wasted on highways and streets; and
- Improving automotive efficiencies.

## Alternative Transit Fuels and Technologies

Transit agencies wishing to reduce greenhouse gas emissions have two options, neither of which involves building rail transit. First, they can use alternative fuel sources and technologies. Second, they can improve their loadings by increasing the average number of people using each transit vehicle or reducing vehicle sizes.

Minneapolis–St. Paul is one of the few regions where a new light-rail line saved energy. In addition to building this line, the region has also reduced greenhouse gas emissions by purchasing hybrid-electric buses and converting to biodiesel fuel for its buses. Hybrid-electric buses are 22 percent more fuel-efficient than regular buses. Biodiesel's net $CO_2$ emissions are two-thirds less than petroleum-based diesel fuel. In 2006, Minneapolis–St. Paul used a fuel mixture of 10 percent biodiesel and plans to increase this to 20 percent in 2008.[55]

Hybrid buses cost more than regular buses, and biodiesel costs more than regular diesel. But they are far more cost-effective at reducing greenhouse gas emissions than building light rail. Minneapolis–St. Paul spent $715 million building its light-rail line.[56] Amortized at 7 percent over 40 years, this is equal to a $53 million annual payment. The transit agency estimates that the light rail saves it $18 million per year in operating costs, so the net cost is $35 million per year.[57] Operating the light rail instead of carrying the same passengers on buses saved about 16 million pounds of $CO_2$, at a cost of more than $2.20 per pound.

In contrast, Minneapolis–St. Paul is purchasing 172 hybrid-electric buses, each costing $200,000 more than a regular bus. Amortizing this cost over 10 years results in an annual cost of about $28,000. The transit agency estimates that each bus will save nearly 2,000 gallons of fuel per year, which would otherwise have generated nearly 44,000 pounds of $CO_2$.[58] This represents a cost of about 60 cents per pound. Hybrid-electric buses are thus 3.5 times more cost-effective at reducing greenhouse gases than light rail. The Minneapolis–St. Paul experience indicates that, even where light-rail operation saved greenhouse gas emissions (not counting construction costs), other methods of reducing $CO_2$ are far more cost effective (see Figure 4).

Biodiesel is even more cost effective. Converting from petroleum diesel to a 20-percent biodiesel mixture saves Minneapolis–St. Paul about 22 million pounds of $CO_2$ per year.[59] The 20-percent biodiesel mixture costs about 20 cents more per gallon and yields about 2 percent less BTUs per gallon than pure petroleum diesel, for a total net cost of less than $2 million per year.[60] Biodiesel thus costs less than 10 cents per pound of $CO_2$ saved, making it more than 25 times as cost-effective at reducing greenhouse gases as light rail.

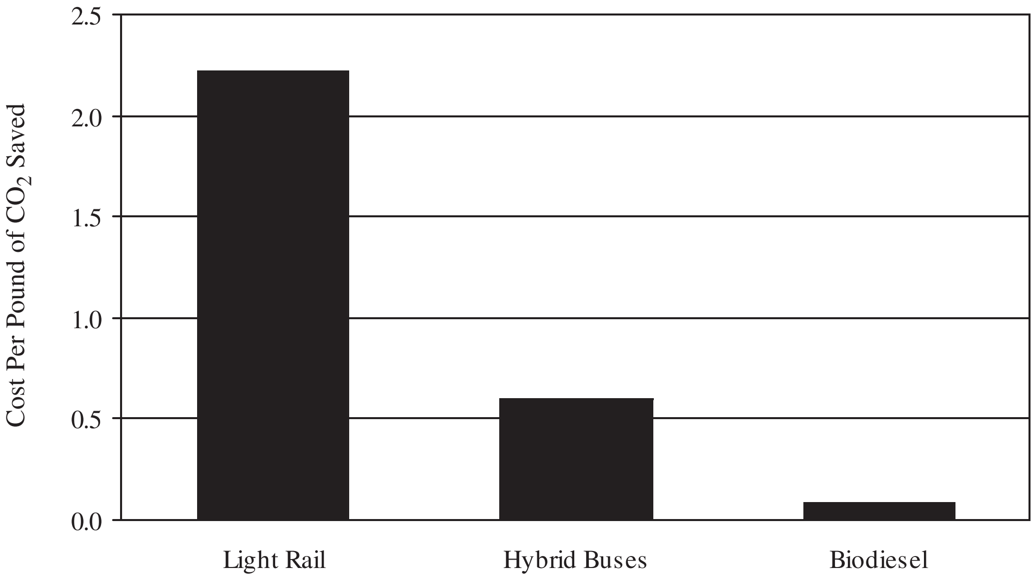
## Increasing Transit Loads

Transit agencies can also save energy by increasing load factors—that is, the percentage of seats and standing room on transit vehicles used in the course of a day. The average transit bus has 39 seats and room for 20 more people standing, yet it carries on average fewer than 11 people. As Figure 5 shows, some transit agencies average more than 20 passengers per bus and consume far less energy per passenger mile.

Regions that rely heavily on non-fossil-fuel sources of electricity have a third option for reducing $CO_2$: electric trolley buses. While trolley buses are not as energy-efficient as diesel buses, they can be greenhouse friendly. Seattle's trolley buses, for example, produce just one-seventh as much $CO_2$ per passenger mile as Seattle's diesel buses.[61] Installing and maintain-

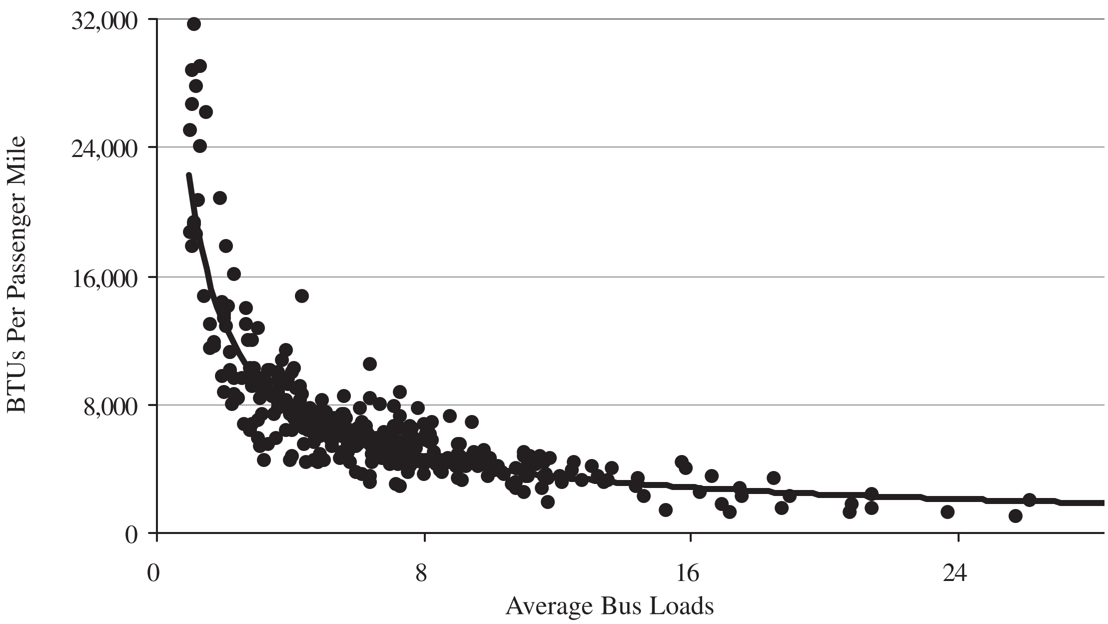
**Hybrid buses and biofuels can reduce one pound of greenhouse gas emissions at a small fraction of the cost of light rail.**

**Figure 4**
**Alternative Greenhouse Gas Strategies**




Source: Caluclations based on data in Peter Bell, "Message from the Council Chair" (St. Paul, MN: Metropolitan Council, 2007), tinyurl.com/2nlxur; Dantata, Touran, and Schneck, "Trends in U.S. Rail Transit Project Cost Overrun," Table 3; Federal Transit Administraion, "Operating Expenses," *2006 Provisional National Transit Database*; Jim Foti, "Hybrid Buses Thunder Down Nicollet Mall—Quietly," Minneapolis Star-Tribune, November 15, 2007, tinyurl.com /2c33mj; Federal Transit Administration, "Fuel Consumption," *2006 Provisional National Transit Database*; and Davis and Diegel, *Transportation Energy Data Book*, Table A.3.

**Figure 5**
**Energy Efficiency of Bus Transit**




Source: Federal Transit Administration, "Energy Consumption," *2006 Provisional National Transit Database* (Washington: U.S. Department of Transportation, 2007), tinyurl.com/3cdn6k.

ing trolley wires is costly, though nowhere near as costly as building rail transit lines.

One way to increase passenger loads is to focus bus service in areas where ridership is highest. Such a market orientation is foreign to transit agencies that are politically pressured to provide service to all taxpaying neighborhoods, even if those neighborhoods offer few riders.

Still, some bus operations are remarkably energy efficient. Several commuter bus lines in the New York metropolitan area consume less than 2,000 BTUs per passenger mile by focusing their services on routes and times that serve large numbers of passengers. Golden Gate Transit in San Francisco–Marin County as well as transit systems in such varied cities as Cumberland, Maryland; Rome, Georgia; Brownsville, Texas; and Santa Barbara, California; all consume less than 3,000 BTUs per passenger mile.

Transit agencies that focus on corridor or commuter routes can save energy while serving suburban neighborhoods or off-peak times by using smaller buses. Transit agencies typically buy buses large enough to meet peak-hour demand and then operate those buses throughout the day. Moreover, federal funding for transit capital purchases gives agencies incentives to buy buses that are larger than they really need even during peak hours. In any case, buying two separate fleets of buses—one for corridors and peak periods and one for suburban routes and off-peak periods—would do more to reduce energy use and $CO_2$ emissions than building rail transit.

Portland's TriMet transit agency, for example, has a fleet of 545 buses in fixed-route service, 90 percent of which have 39 seats or more. TriMet could supplement these buses with 500 15- to 25-passenger buses costing \$50,000 to \$75,000 each.[62] This would total \$25–37 million—about the cost of one mile of light-rail line. Amortized over 10 years, this is about \$5 million per year.

The smaller buses consume only about 40 percent as much fuel and emit 40 percent as much $CO_2$ as full-sized buses. TriMet buses produced 129 million pounds of $CO_2$ in 2006, so operating smaller buses for even one-third of vehicle-hours of service would save 25 million pounds of $CO_2$. Savings on fuel would offset at least \$1 million of the \$5 million amortized cost of buying these buses. Thus, the reductions in $CO_2$ levels would cost only about 16 cents per pound.

## Saving Energy on Highways and Streets

The Texas Transportation Institute estimates that more than 2.9 billion gallons of fuel are wasted in congested traffic each year.[63] Relieving the congestion by fixing bottlenecks, using congestion tolls, and adding new capacity will do far more to reduce energy than rail transit can. Moreover, new highways largely pay for themselves, especially if tolls are used, while rail transit requires huge subsidies.

Some people fear that relieving congestion will simply induce more driving, and the energy costs of that driving will cancel out the savings from congestion relief. The induced-demand story is as much a myth as the claim that General Motors shut down streetcar systems in order to force people to buy cars.

Not building roads out of fear of induced demand is "wrongheaded," says University of California planning professor Robert Cervero. "The problems people associate with roads—for example, congestion and air pollution—are not the fault of the road investments," he adds. They result "from the *use* and *mispricing* of roads."[64]

Historically, gasoline taxes and other highway user fees have paid nearly 90 percent of all the costs of building, maintaining, and policing American roads and streets.[65] (In contrast, transit fares cover only about 40 percent of transit operating costs and none of transit capital costs.) The problem with gas taxes as a user fee, however, is that they do not signal users about the costs of the services they are consuming. Building a system that can meet peak-period demand costs more, yet peak-period users pay about the same user fee as off-peak users.

**Relieving traffic congestion by fixing bottlenecks, using congestion tolls, and coordinating traffic signals will do far more to save energy than rail transit.**

There may be reasons to build rail transit, but saving energy and reducing greenhouse gas emissions are not among them.

The solution is to charge tolls for new highway capacity, and vary the tolls by the amount of traffic so that new highway lanes never become congested. Existing high-occupancy vehicle lanes, which often have surplus capacity, can also be converted to high-occupancy toll (HOT) lanes, as has been successfully done in Denver.[66] Toll revenues will cover the costs of new roads, but higher tolls during peak periods will reduce the need for more roads.

So far, tolls have been applied only to limited-access highways. But traffic engineers can do much to reduce $CO_2$ emissions on unlimited access roads by improving traffic signal coordination.

San Jose coordinated 223 traffic signals on the city's most-congested streets at a cost of about $500,000. Engineers estimate that this saves 471,000 gallons of gasoline each year, which translates to a 9.2-million pound reduction in $CO_2$ emissions.[67] That works out to a cost of just 5.4 cents per pound. Not only were greenhouse gases reduced, but motorists saved time, safety improved, and toxic air pollution was reduced as well.

According to the Federal Highway Administration, three out of four traffic signals in the nation are obsolete and poorly coordinated with other signals.[68] The National Transportation Operations Coalition says that deficiencies in signal coordination "are remarkably similar across the country and across jurisdictions."[69] Cities that have not budgeted the funds to improve traffic signal coordination have no business spending hundreds of millions of dollars building light-rail lines in the forlorn hope that rail transit will reduce $CO_2$ emissions.

## Improving Automobile Efficiencies

The Energy Independence and Security Act of 2007 requires that the average new car sold in 2020 get 35 miles per gallon. Yet even under this law, the average car on the road in 2020 will get only about 25 miles per gallon. Cities that want to accelerate this process are likely to find that giving people incentives to buy fuel-efficient cars will be a more cost-effective way of reducing energy consumption and greenhouse gas emissions than building rail transit.

Since 1992 American cities have invested some $100 billion in urban rail transit.[70] Yet no rail system in the country has managed to increase transit's share of urban travel by even 1 percent.[71] Between 1990 and 2005, the only rail region that managed to increase transit's share of commuting by more than 1 percent was New York, and it did so mainly by lowering transit fares. Meanwhile, transit actually lost a share of passenger travel and commuters in most rail regions.[72] Thus, rail transit promises, at best, tiny gains for huge investments.

Considering rail transit's poor track record, persuading 1 percent of auto owners to purchase a car that gets 30 to 40 miles per gallon or better the next time they buy a car will do more to reduce energy consumption and $CO_2$ emissions than building rail transit. Only minimal incentives might be needed to achieve this, making such incentives far more cost effective than building rail transit.

## Conclusion

There may be places in the world where rail transit works. There may be reasons to build it somewhere in the United States. But saving energy and reducing greenhouse gas emissions are not among those reasons. Regions and states that want to be green should find cost-effective alternatives such as the ones described here.

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Policy Analysis

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# The Myth of the Compact City
## Why Compact Development Is Not the Way to Reduce Carbon Dioxide Emissions

by Randal O'Toole

## Executive Summary

Proponents of compact development argue that rebuilding American urban areas to higher densities is vital for reducing greenhouse gas emissions. Compact city policies call for reducing driving by housing a higher percentage of people in multi-family and mixed-use developments, reducing the average lot sizes of single-family homes, redesigning streets and neighborhoods to be more pedestrian friendly, concentrating jobs in selected areas, and spending more on mass transit and less on highways.

The Obama administration has endorsed these policies. Secretary of Transportation Ray LaHood and Secretary of Housing and Urban Development Shaun Donovan have agreed to require metropolitan areas to adopt compact-development policies or risk losing federal transportation and housing funds. LaHood has admitted that the goal of this program is to "coerce people out of their cars."

As such, compact-development policies represent a huge intrusion on private property rights, personal freedom, and mobility. They are also fraught with risks. Urban planners and economists are far from unanimous about whether such policies will reduce greenhouse gas emissions. Some even raise the possibility that compact city policies could increase emissions by increasing roadway congestion.

Such reductions are insignificant compared with the huge costs that compact development would impose on the nation. These costs include reduced worker productivity, less affordable housing, increased traffic congestion, higher taxes or reduced urban services, and higher consumer costs. Those who believe we must reduce carbon emissions should reject compact development as expensive, risky, and distracting from tools, such as carbon taxes, that can have greater, more immediate, and more easily monitored effects on greenhouse gas emissions.

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**Compact development policies, admits Transportation Secretary Ray LaHood, are designed "to coerce people out of their cars."**

## Introduction

The Obama administration has endorsed proposals to direct metropolitan areas to become more "compact" in order to reduce greenhouse gas emissions. Such a compact-development policy calls for increasing urban population densities, housing more people in multi-family and mixed-use developments, investing more in mass transit and less in infrastructure for personal transportation, and concentrating jobs in selected areas.

The major premises behind this policy are that people living in compact cities drive less, and that the United States cannot meet targets for reducing greenhouse gas emissions without reducing the growth of driving. The "transportation sector cannot do its fair share to meet this [greenhouse gas reduction] target through vehicle and fuel technology alone," says *Growing Cooler*, a 2008 report from the Urban Land Institute. This is because, the report explains, the predicted growth in driving is greater than predicted reductions in emissions from more efficient cars and alternative fuels.[1]

To reduce driving, *Growing Cooler* advocated the use of "compact development" combined with "expanded transportation alternatives." Compact development, says *Growing Cooler*, means "higher average 'blended' densities" along with "a mix of land uses, development of strong population and employment centers, interconnection of streets, and the design of structures and spaces at a human scale."[2]

One month after publication of *Growing Cooler*, the Brookings Institute released *Shrinking the Carbon Footprint of Metropolitan America*. The report urged the federal government to use its housing and transportation programs to encourage or require metropolitan areas "to expand transit and compact development."[3]

In 2009, the Urban Land Institute and several other groups published *Moving Cooler*, a sequel to *Growing Cooler*. The report claimed that "smart growth"—a combination of compact development and "improved travel options"—could reduce 2050 greenhouse gas emissions by 9 to 15 percent.[4]

Another 2009 report from the Center for Clean Air Policy promoted "greenhouse gas reductions through smart growth and improved transportation choices" and proposed that cap-and-trade revenues be invested in such programs. The report went further and argued that such changes would be "cost-effective" and even "profitable."[5]

Most recently, a report from the Transportation Research Board, *Driving and the Built Environment*, concluded that doubling the density of most new development and making other land-use changes such as concentrating jobs, mixed-use developments, and significant transit improvements, could reduce miles of driving and auto-related carbon dioxide emissions by up to 11 percent.[6]

Coming at a time when Congress is debating both climate policy and transportation reauthorization, these reports are clearly aimed at promoting a national smart-growth policy that would dictate land uses and transportation spending for the next several decades. The reports have clearly influenced the Obama administration, which has endorsed the goal of reducing driving through compact-city policies. The secretaries of transportation and housing and urban development have signed an agreement to require metropolitan areas to adopt compact development policies.[7] Secretary of Transportation Ray LaHood has admitted that these policies are designed to "coerce people out of their cars."[8]

Yet the reports supporting compact cities contain major flaws. First, they typically overstate the effects of compact development on greenhouse gas emissions. Second, they ignore or vastly underestimate the costs of compact development, alternative forms of transportation, and restrictions on personal mobility. Further, they ignore or underestimate the risks that compact development will not produce the intended effects or that unintended consequences will prove far more costly than any benefits that result.

The reports' failure to accurately assess benefits and costs obscures the fact that compact city policies are extremely expensive, yet they will likely yield negligible (and possibly negative) environmental benefits. Given limited resources, if other means of reducing greenhouse gases are more cost efficient, then promoting or requiring compact development will make it more difficult to achieve emission reduction targets.

## History of Compact City Planning

For more than 75 years, architects and urban planners have proposed compact development as an alternative to low-density suburbs, which they derisively term "sprawl." In addition to higher-density housing, most compact city proposals also include plans to make neighborhoods more pedestrian-friendly and include investments in mass transit and other alternatives to auto driving. Together, compact development and alternative transportation projects are sometimes called "smart growth."

Although the term smart growth was not applied to these policies until 1996, the desire on the part of urban planners and some environmentalists for higher urban densities long predates that year or any concerns about global climate change. Criticism of low-density suburbs dates back at least to the 1930s.[9] First in Europe and later in the United States, those critics have sought to use the power of government to herd large segments of the population into high-density cities and to prevent owners of rural land from developing their property for residential uses.

One of the first to promote such policies was Le Corbusier, a Swiss-French architect who promoted the reconstruction of cities into vast regions of high-rise apartments that he called "Radiant Cities." His ideas so heavily influenced urban planners throughout the world in the 1940s and 1950s that planning historian Peter Hall calls Corbusier "the Rasputin of this tale," both because Radiant Cities turned out to be unlivable and because of his authoritarian approach to planning, "the evil consequences of which are ever with us."[10]

In 1947, the British Parliament passed the Town and Country Planning Act, which could be described as the first modern compact-city law. This law set aside vast regions of rural land as greenbelts and mandated the construction of high-density, high-rise housing within existing cities along Radiant City lines.

Unlike the United States, which built public housing only for the poor, the British government built these apartments for working-class and middle-class families. Many of the buildings proved to be so unlivable, observes Hall, that "the remarkable fact was how long it took for anyone to see that it was wrong."[11] By the late 1960s, few people were willing to live in such apartments even at heavily subsidized rents, and so by 1970, says Hall, "the great Corbusian rebuild was over."[12]

The United States built its Radiant City housing exclusively for low-income families, but had the same experience. The housing projects became so plagued by crime and vandalism that most have been demolished.[13]

One of the leading critics of the standard urban renewal practices of the 1950s—clearing "slums" and replacing them with high-rise housing—was Jane Jacobs, author of *The Death and Life of Great American Cities*. Jacobs lived in a mid-rise, mixed-use, inner-city neighborhood that was slated for urban renewal, and she sought to prove that her neighborhood was "lively," and not a blighted slum that needed to be replaced.[14]

Urban planners learned a lesson from *The Death and Life*, but it was the wrong one. Instead of realizing that cities are too complicated to be centrally planned, they concluded that central planners should promote Jacobs's mid-rise neighborhoods instead of Corbusier's high-rise apartments.

This transition is apparent in a 1973 book, *Compact City*. "The problems of urban development," write authors George Dantzig and Thomas Saaty, "are too crucial to the future to be left to real-estate developers"—in other words, private landowners who meet market demand by building low-density sub-

**Compact development proposals date back at least to the 1930s and the British Parliament passed the first compact-development law in 1947.**

**After the developer of a New Urban project designed by Peter Calthorpe went bankrupt, Calthorpe went into the business of helping cities writing codes mandating New Urban development.**

urbs. Central planners should insist on higher-density development.[15]

The book's main proposals were "in some respects based on Radiant City lines" (which reveals how slow planners are to learn from their mistakes). As an alternative, however, the authors' proposed that density could be achieved using Jacobs's "lively neighborhoods."[16] Either way, the authors call for a top-down planning approach that would give property owners and homebuyers little choice but to accept the dictates of the supposedly omniscient planners.

In the 1980s, a number of architects proposed to build Jacobs's lively neighborhoods from scratch. On the East Coast, Andres Duany suggested that such "neotraditional" neighborhoods would have a stronger sense of community than traditional low-density suburbs.[17] On the West Coast, Peter Calthorpe claimed that pedestrian-oriented "urban villages" would be less "dependent" on the automobile.[18] These ideas soon became known as "New Urbanism."

New Urbanists, however, soon ran into a brick wall of market reality: surveys and actual buying habits have repeatedly shown that the vast majority of Americans aspire to live in a single-family home with a large yard.[19] While New Urbanists accepted some single-family homes, they wanted to increase the percentage of people living in multi-family housing and build single-family homes on tiny lots. There is a small market for high-density, mixed-use neighborhoods, but in many cities that market is easily met by existing older neighborhoods.

As a result, many early New Urban developments were financial failures. After the first developer of Calthorpe's Laguna West, near Sacramento, went bankrupt, a later developer reconfigured and completed it as a traditional suburb. Calthorpe soon went into the business of helping cities write codes mandating New Urban development. Such mandates came to be known as "smart growth," a term that became popular partly because advocates often construe anyone who supports property rights and freedom of choice as promoting "dumb growth."[20]

## The Solution in Search of a Problem

Throughout most of this history, compact development was a solution in search of a problem. Early advocates claimed that denser development was needed to preserve farmlands. Yet the United States has a billion acres of agricultural lands, less than 40 percent of which are actually used for growing crops, while the nation's urban areas occupy only about 100 million acres.[21] So, compact development for the purpose of farm preservation made little sense.

In the 1970s, advocates of compact development argued that it would reduce air pollution and save energy because people living in compact cities would drive less. Yet it proved to be far easier to simply build cleaner, more fuel-efficient cars than to completely rebuild American cities.

Between 1970 and 2007, for example, urban driving increased by 250 percent, but auto-related air pollution declined by more than two-thirds.[22] Meanwhile, Americans responded to higher gas prices in the 1970s and early 1980s by buying cars in the 1990s that were an average of 40 percent more fuel efficient than those available in the early 1970s.[23] In 1991, for example, Americans drove 41 percent more miles than in 1978, while using only 3 percent more fuel.[24] After gas prices fell, Americans bought larger cars, but technological improvements produced a continuing increase of ton-miles-per-gallon.[25] This shows that considerable progress can be made in improving fuel economy without reducing mobility.

Another early argument for regulating sprawl was that the cost of providing infrastructure to low-density communities was significantly greater than in higher-density areas.[26] The most detailed study of this question concluded that low-density suburban development imposes about $11,000 per residence more in urban-service costs on communities than more compact development.[27] Some have questioned this number.[28] But even if valid, most homebuyers would gladly add $11,000 to the cost of a $150,000 home in order to have a good-sized yard and not share a wall with next-door neighbors.

In the 1980s and 1990s, some New Urban advocates argued that denser neighborhoods had a stronger sense of community. Studies have found, however, that suburbs actually have more social interactions than denser cities.[29] Even the data in Robert Putnam's *Bowling Alone*, which promoted the notion that Americans were losing their sense of community, showed that suburbanites had higher social participation rates than residents of dense cities.[30]

In the early 2000s, compact-city supporters jumped on the obesity issue by claiming that suburbs make people fat. In fact, even studies prepared by smart-growth supporters found that the differences in obesity rates between low- and high-density areas were trivial. One study found, for example, that about 2 percent more people in low-density Atlanta are obese than in high-density San Francisco.[31] More careful studies have found "no evidence that urban sprawl causes obesity." In fact, these studies say, compact-city advocates confused cause and effect: "individuals who are more likely to be obese choose to live in more sprawling neighborhoods."[32]

If all these reasons for supporting compact cities are wrong, then why is the idea so persistent? The answer, at least in part, says Peter Hall, is that it is a class conflict. Ironically, Hall observes, before 1920 the main goal of urban planners was to move working-class people from high-density inner-city tenements to low-density suburbs. No one complained about urban sprawl when low-density suburbs were occupied solely by the upper and middle classes. But when working-class families started moving to the suburbs—more due to Henry Ford's mass-produced automobiles than to anything urban planners did—conflicts between upper- and lower-class tastes led to a backlash.[33] While often giving lip service to the idea of mixed-income communities, the elites decided to promote policies that made single-family housing unaffordable to all but the wealthy.

Now compact-city advocates have hitched their wagon to the climate-change debate. However, instead of advocating the most efficient (and thus resource-conservative) ways of reducing greenhouse gas emissions, these advocates have co-opted climate concerns to justify their preferences for urban planning. Consider:

- The lead author of *Growing Cooler*, Reid Ewing, was also the lead author of the study (which he brags is "the most widely reported planning study ever") that erroneously claimed suburbs make people obese.[34]
- *Growing Cooler* co-author Keith Bartholomew was staff attorney for 1000 Friends of Oregon in 1989, where he directed the Land Use-Transportation-Air Quality project that developed much of the modern conception of compact development.[35] Another co-author, Don Chen, is a former staff member of the Surface Transportation Policy Project, which has sought to reduce driving since its creation in 1990.
- Many of the organizations behind the *Moving Cooler* report, including the American Public Transportation Association, Environmental Defense Fund, Natural Resources Defense Council, and Environmental Protection Agency, have promoted compact cities for at least 15 years.
- Several people listed on the Center for Clean Air Policy report as having provided "assistance" to the authors have also promoted compact cities.

Some, though certainly not all, of the members of the Transportation Research Board committee that oversaw that organization's report have also long been compact-city advocates.

In other words, these reports have been written or influenced by people who supported compact development long before climate change became a major issue. Now they are using climate change to justify imposing their preferred form of urban planning on major U.S. metropolitan areas.

**No one complained about sprawl when suburbs were occupied solely by upper and middle classes. It was only when working-class families moved to the suburbs that critics proposed to force them into compact developments.**

**If the United States decides to reduce greenhouse gas emissions, other policies are far more cost-efficient than compact development.**

Rebuilding American cities to more compact standards would certainly qualify as a megaproject. Bent Flyvbjerg, a Danish planner who has studied numerous megaprojects, observes that megaproject advocates are often guilty of *optimism bias*, in which they overestimate benefits and underestimate costs, and *strategic misrepresentation*, in which they skew data to make their project look more favorable than it really is.[36]

For example, *Growing Cooler* optimistically estimated that building 60 percent of new urban development to compact standards would reduce 2030 carbon dioxide emissions by 79 million tons.[37] Somewhat more realistically, *Moving Cooler* estimated that building 64 percent of new urban development to compact standards would reduce 2030 carbon dioxide emissions by only 22 million tons, indicating that *Growing Cooler* overestimated the effects of compact development by nearly four times.[38] In its own example of optimism bias, however, *Moving Cooler* projects that the cost of building up to 90 percent of all new urban development in the U.S. to compact standards would be only $1.5 billion.[39]

Policy advocates who couch their ideas in language that disguises the weaknesses of their proposals are guilty of strategic misrepresentation. For example, *Growing Cooler*'s repeated statement that transportation accounts for one-third of greenhouse gas emissions (modified to 28 percent in *Moving Cooler*) obscures the fact that urban driving of personal vehicles—the form of transportation advocates seek to reduce through compact development—accounts for less than 13 percent of emissions, while the other 20 percent comes from freight, mass transportation, and intercity travel.[40]

A careful reading of the various compact-city reports reveal numerous other optimism biases and strategic misrepresentations that overestimate the benefits and underestimate the costs of these proposals. Correcting these biases and misrepresentations reveals that compact development would be a wasteful and inefficient way of achieving greenhouse gas reductions.

## Compact Cities and Greenhouse Gases

All of the reports discussed in this paper take it for granted that the United States must reduce carbon dioxide emissions by as much as 80 percent from 1990 levels—which would mean 83 percent from 2007 levels. Though many climatologists dispute this goal, such disputes are beyond the scope of this paper.[41]

Instead, the point of this paper is that *if the United States decides to reduce greenhouse gas emissions, there are more cost-efficient policies to achieve this goal than compact development*. Given that resources are limited, any project that reduces greenhouse gas emissions in a non-cost-effective manner will simply make it more difficult to meet emission reduction targets.

According to a McKinsey and Company report, the United States can meet emission reduction targets by investing in projects that cost less than $50 per ton of carbon-dioxide-equivalent emissions. Close to half of the reductions, the company found, would actually have a negative cost: though they may require up-front investments, they would save money in the long run by reducing energy costs. These projects would include designing cars and light trucks that are lighter-weight and have less wind and rolling resistance.[42]

In contrast to McKinsey's rigorous analysis of cost-effectiveness, none of the reports advocating compact development show that such policies would be cost-effective, and most do not even mention cost-effectiveness. In fact, to the extent that compact development can reduce greenhouse gas emissions at all, it would do so only at a cost far greater than $50 per ton. This means it should be among the last policies to be adopted in response to climate concerns.

### Growing Cooler

*Growing Cooler* insists that reductions in the growth of driving are needed so that transportation will contribute its "fair share" of greenhouse gas reductions.[43] But what is fair? The report implies that, since transportation accounts for a third of emissions, it should provide a third of total emission reductions. This ignores the fact that emissions reductions can be achieved in other sectors much more cheaply and easily, which would be far more efficient for society. For example, the McKinsey study found that more than half of the cost-effective opportunities for emission reductions are in the electricity sector, while transportation offers only 15 percent of such opportunities.[44] Unless advocates of compact development can prove that their policies would cost less than $50 per ton, proposals to reduce driving to meet emission-reduction targets are almost certain to be cost-ineffective.

Even among transportation investments, *Growing Cooler* provides no evidence that compact development is a cost-effective solution to greenhouse gas emissions. Instead, it relies on a weak metaphor of a three-legged stool, the legs being more fuel-efficient cars, alternative fuels, and reduced driving. The first two "legs" alone will not meet emission-reduction targets, says the report, so we must reduce driving.[45]

The only evidence the report offers that the first two legs are insufficient is based on the corporate average fuel economy (CAFE) standard in the Energy Independence and Security Act of 2007, which called for increasing the average fuel economy of cars to 35 miles per gallon by 2020. The report also accounts for a federal requirement that alternative fuel use be increased so as to reduce carbon dioxide emissions by about 10 percent. The report shows that the emission reductions from these two standards will be offset by increases in driving. This leads to the conclusion that driving must be reduced.[46]

In effect, the report assumes that no further increases in fuel efficiencies or alternative fuels are possible beyond those in the 2007 law. That assumption has already been proven obsolete, because in 2009 auto manufacturers accepted an even tighter CAFE standard of 35.5 mph by 2016. The report further assumes that auto manufacturers will make no additional improvements in fuel efficiency or alternative-fueled autos after 2020. *Growing Cooler* tracks emissions through 2050, yet it effectively assumes technology will freeze after 2020, barely a quarter of the way through the time-horizon of the report. Accepting that this is unlikely greatly shrinks the imperative to reduce driving.

Data buried in the back of *Growing Cooler* suggest that, to the extent that reductions in driving can contribute at all to greenhouse gas reductions, only a small share of that contribution will come from compact development. The report evaluates four policies that together, it concludes, could reduce driving by 38 percent. Of those policies, the two *smallest* reductions in driving come from increased investments in transit, which would reduce driving by only 4.6 percent, and increased population densities, which would reduce driving by 7.7 percent.

The greatest reduction in driving comes from an assumption that fuel prices will rise at rates that are significantly faster than historical levels (possibly through higher fuel taxes), which would reduce driving by 14.4 percent. This is closely followed by a policy of reducing investments in new highways, which would increase the growth in congestion and reduce driving by 11.4 percent.[47]

In other words, two-thirds of the projected reductions in driving come from making driving more expensive, not from land-use changes or investments in alternatives to driving. This reveals that compact-city policies are far less effective than its proponents imply, and that the compact-city agenda is far more coercive—relying more on punitive pricing measures than changes to the built environment—than its proponents admit.

In an effort to show that its policies are not necessarily coercive, *Growing Cooler* argues that increasing numbers of Americans want to live in more compact cities. The report relies heavily on the projections of an urban planning professor named Arthur Nelson, who claims that by 2025 the United States will have a surplus of single-family homes on large lots and all new construction will have to be multi-family housing or single-family homes on small lots.[48]

**Most of the reductions in driving in *Growing Cooler* come from policies that make driving more expensive, not from compact development.**

**Those who believe we should reduce carbon emissions should reject compact development as expensive, risky, and likely to distract attention from more cost-effective emission-reduction programs.**

However, Nelson himself is guilty of optimism bias. He claims that only 25 percent of Americans want to live in single-family homes on large lots, while 37 percent want small lots (less than one-sixth of an acre) and 38 percent prefer multi-family housing. These numbers, he says, are "based on interpretations of surveys" reported by urban planners Dowell Myers and Elizabeth Gearin.[49] Yet the Myers-Gearin paper completely contradicts Nelson's "interpretation," citing survey after survey finding that 75 to 85 percent of Americans aspire to live in single-family homes with a yard.[50]

If compact-city advocates truly believed in Nelson's numbers, they would not need to use regulation to increase densities of American cities. Builders responding to market demand alone would make cities denser. But in fact, achieving *Growing Cooler*'s compact-city goals will require a degree of coercion from the federal government that is unprecedented in American history: limits on rural land development, mandated changes to existing residential areas, and huge taxpayer-supported subsidies to entice people to live in higher-density complexes.

**Shrinking the Carbon Footprint**

The Brookings Institution report is the only one considered in this paper that deals with greenhouse gas emissions from sources other than transportation. Not only will compact cities reduce driving, says the report, but they will also reduce the energy consumption and greenhouse gas emissions from housing and other buildings.

Buildings, the report points out, account for even more carbon emissions than transportation—39 percent vs. 33 percent.[51] The report advocates compact development to reduce these costs through "smaller homes and shared walls in multi-unit dwellings."[52]

As with *Growing Cooler*'s demand that we reduce driving, the Brookings report fails to show that compact development is a cost-effective way of saving energy or reducing greenhouse gases from residential or other buildings. According to the Department of Energy, single-family homes actually consume less energy per square foot than multi-family homes. Despite their shared walls, two- to four-unit multi-family homes use 25 percent more energy per square foot, while residences with five or more units use 8 percent more, than single-family detached homes.[53]

This means the Brookings study is really proposing to save energy by forcing Americans to drastically reduce the size of their living spaces. Yet it is likely that technological improvements—better insulation, designs that take better advantage of solar heating opportunities, and so forth—could achieve far more energy savings at a lower cost without requiring dramatic changes in lifestyles. Just as compact-city advocates consider technological solutions that make driving more energy-efficient to be inadequate, the Brookings report implicitly considers technological solutions that make single-family housing more energy-efficient to be insufficient.

**Cost-Effective GHG Reductions**

The Center for Clean Air Policy report shares a co-author, Steve Winkelman, with *Growing Cooler*—along with many of the latter report's arguments. But it also claims to prove that compact development is a cost-effective means of reducing greenhouse gases. In fact, the report claims that reducing per capita driving by 10 percent "can be achieved profitably, when factoring in avoided infrastructure costs, consumer savings and projected tax revenue growth."[54]

Typically, the report offers almost no real-world data to support this conclusion. Instead, it relies on the projections of urban planners in Atlanta, Portland, Sacramento, and elsewhere for how their policies will affect energy consumption and other behaviors. Though it calls these "case studies," the report's arguments suffer from optimism bias and strategic misrepresentations.[55]

For example, CCAP reports that Sacramento's "smart-growth plan is projected to reduce emissions [at] a net economic benefit of $198 per ton carbon dioxide." Yet Sacramento has been using smart-growth plans requiring compact development and investments in transit for decades, but the environmental gains from these efforts seem to be minimal. The region's 2006 plan openly admitted that its smart-growth plans imposed "during the past 25 years have not worked out." Despite building light rail, the share of transit riders who "have access to an automobile [and] can otherwise choose to drive" is decreasing. Despite efforts to promote compact development, both jobs and residences continued to decentralize. Despite the region's failure to build new roads to accommodate growth, "lack of road building and the resulting congestion have not encouraged many people to take transit instead of driving."[56] Despite the failure of past plans, Sacramento adopted a plan that continued these failed policies and projected benefits that were based more on hope than experience.

The CCAP report breathlessly notes "that $73 million invested in the Portland Streetcar helped attract $2.3 billion in private investment within two blocks of the line."[57] What it does not say is that, at the same time that it built the streetcar line, Portland spent more than $665 million subsidizing new developments along the line, including building parking garages for retailers, subsidizing an aerial tram, parks, and parking garages for a development near the Oregon Health Sciences University, and providing 10 years of property-tax waivers to many residences that were built along the streetcar line.[58]

Except for the property-tax waivers, most of these subsidies came from tax-increment financing, which effectively transfers tax revenues from schools, fire, police, and other essential services to property developers. Far from being "profitable," as CCAP claims, such transfers give residents a choice between declining urban services and higher taxes to replace the funds lost to schools and other urban services.

CCAP claims that the Atlanta development Atlantic Station will reduce greenhouse gas emissions "at a net cost savings, because municipal tax revenues from the project will be greater than what is required to pay back the initial project loan."[59] As in the case of Portland, the "initial project loan" is a $75 million tax-increment financed subsidy to the developers.[60] What CCAP does not reveal is that the tax revenues required to repay this subsidy would otherwise go to schools and other essential urban services for Atlantic Station.

The problem with relying on projections rather than reality is that the projections are often made by planners who themselves suffer from optimism bias and strategic misrepresentation. For example, planners typically portray tax-increment financing as a way of "self-financing" economic development. Yet the new development requires the same urban services as existing development, but the taxes that would have gone to those services are transferred to the developers instead.

In most cases, subsidies to economic development are, at best, a zero-sum game: if planners subsidize it to take place in a dense section of a city, it will not take place somewhere else. So planners cannot claim the benefits of that development as a net gain for the city or region; in fact, the tax subsidy is a net loss. At worst, such subsidies are a negative-sum game: by increasing taxes or reducing urban services, they discourage employers from moving to or remaining in the region. As a study in Illinois found, communities that use tax-increment financing actually "grow more slowly than those that do not."[61]

In Sacramento and Portland, at least, tax increases ordinarily require voter approval. But tax-increment financing is exempt from this requirement. Far from being profitable, cities that use tax-increment financing to support compact development are effectively stealing from schoolchildren, firefighters, and other recipients and providers of urban services—and, in turn, stealing from the taxpayers who agreed to fund those services.

**CCAP's claims that compact development is "cost effective" are based on projects in which cities effectively steal money from schools, fire, and police to subsidize developers.**

**Moving Cooler**

While *Moving Cooler* is in many ways a sequel to *Growing Cooler*, it maintains a patina of greater objectivity because it was written by a consulting firm, Cambridge Systematics, rather than by employees of organizations that have supported compact development for two

**It is more cost-effective to dedicate renewable energy to electric cars and plug-in hybrids, which can be recharged overnight when electricity demand is low, then to use it for transit in day times, when demand is high.**

decades. Yet *Moving Cooler* relies on many of the same sources as *Growing Cooler*, and background documents specifically cite *Growing Cooler* as the source of many of the new report's assumptions.

For example, *Moving Cooler* uses Arthur Nelson's projections, "as cited in *Growing Cooler*," of the future demand for various types of housing.[62] It based its estimate of the reductions in driving due to "pedestrian-friendly environments" on a paper by Ewing (a *Growing Cooler* co-author) and Cervero, "also cited in *Growing Cooler*."[63]

Cambridge Systematics also relied on a paper by the Center for Clean Air Policy for nearly all of its numbers relating to high-speed rail.[64] This paper contained many examples of optimism bias and strategic misrepresentation. For example, the paper assumed that high-speed trains would operate 70 percent full.[65] Yet Amtrak trains in 2008—a banner year for passenger trains due to high gas prices—were only 52 percent full.[66]

Unlike most of the other reports considered here, *Moving Cooler* compares compact development with other ways of reducing vehicle-related greenhouse gas emissions, including parking and highway pricing, carbon taxes, ridesharing and similar commuting strategies, intelligent transportation systems, and highway capacity expansions.[67] Though the report estimates the costs and emission reductions from "expanded," "aggressive," and "maximum" levels of each strategy, it does not take the next step of calculating the cost per ton of abatements.

Those costs range from pennies to $5,900 per ton. Of 47 strategies considered, only 21 are estimated to cost $50 per ton or less, and in some cases the cost is less than $50 at only some levels of implementation. For example, "expanded incident management" costs $37 per ton, but "maximum incident management" costs $161 per ton.[68]

Even though the report provides readers with enough data to calculate costs per ton, many of the cost and benefit estimates are questionable. For example, maximum expansions of transit service are estimated to produce 1.5 billion metric tons of greenhouse gas reductions. This seems questionable considering that transit produces about the same amount of greenhouse gases per passenger mile as automobiles.[69]

To reach this conclusion, Cambridge Systematics assumed that new technologies would reduce greenhouse gas emissions per passenger mile from buses by 26 percent and from rail transit by 50 percent or more, even if passenger loadings remain about the same as they are today.[70] This is extremely unlikely, particularly for rail transit. America's automobile fleet turns over every 18 years, so by 2050 we will have two completely new generations of automobiles on the roads, many of which will be lighter and have less wind- and rolling-resistance than today's cars. But rail transit fleets turn over only once every 30 to 40 years, and there is little reason to think that future vehicles will be significantly more fuel-efficient than the ones on the rails today.[71]

Moreover, both bus and rail transit vehicles are significantly less fuel efficient, per passenger mile, today than they were in 1980.[72] This is mainly due to a decline in passenger loadings that has resulted from expansions of service into areas that make little use of transit. Cambridge Systematics' assumption that a huge expansion of transit service will not reduce average passenger loads is likely to be optimistic.

The one way in which transit expansions could significantly reduce greenhouse gas emissions is if the transit were powered by non-fossil-fuel sources of electricity. But it would be more cost-effective to dedicate such electricity to electric cars and plug-in hybrids, which can be recharged overnight when electricity demand is low, and allow daytime use of that electricity for other purposes.

Even with Cambridge Systematics' generous assumptions regarding improvements in transit efficiencies, the cost of the maximum transit expansions is more than $2,000 per ton, while the cost of lesser expansions exceeds $1,700 per ton. This is far more than can be considered cost-effective under the McKinsey report's guideline of $50 per ton.

According to *Moving Cooler*, compact-development strategies are very cost-effective, ranging from $1 to $9 per ton. But the costs projected by Cambridge Systematics are extremely low. It claims that compact development nationwide would cost the same $1.5 billion under the expanded (43 percent of new development is compact), aggressive (64 percent), and maximum (90 percent) levels of deployment of compact city policies.[73] At apparently no extra cost, the maximum level is projected to reduce greenhouse gas emissions by more than 9 times the expanded level.

This report will show that compact development will cost far more than $1.5 billion. But even under the maximum level, Cambridge Systematics estimates that compact development will reduce greenhouse gas emissions by just 38 million tons in 2030, or about a half a percent of current U.S. emissions. By 2050 this would increase to 73 tons, or about 1.3 percent of current emissions.[74]

**Driving and the Built Environment**

The Transportation Research Board report, *Driving and the Built Environment: The Effects of Compact Development on Motorized Travel, Energy Use, and Carbon Dioxide Emissions*, has an even stronger claim to objectivity than *Moving Cooler*. The report was written under the supervision of a 12-member committee that included a mix of planners and transportation engineers. Some members of the committee—most notably Dianne Brake of PlanSmart NJ, Andrew Cotugno of Metro (Portland's metropolitan planning organization), and Rolf Pendall of the Cornell University City and Regional Planning Department—have been unabashed supporters of compact development, but others have been more skeptical.

"Evidence from the literature," says the report, indicates "doubling density is associated with about 5 percent less VMT [vehicle miles traveled] on average." When "other land-use factors" such as mixed uses and pedestrian-friendly design are taken into account, "reports find that VMT is lower by an average of 3 to 20 percent."[75]

The report compares a base case (no action) with two scenarios: one in which 25 percent of all future urban development is built to twice the existing urban densities and one in which 75 percent is built to twice the current densities. The report arbitrarily assumed that residents of compact developments would drive 12 percent less than average under the 25-percent scenario and 25 percent less than average under the 75-percent scenario.[76] This is particularly optimistic considering that the report's own literature review found driving reductions of just 3 to 20 percent.

Based on these assumptions, the report projects that total miles of driving would be 1 percent less than the base case under the 25-percent scenario, and up to 11 percent less under the 75-percent scenario. The report adds that "the committee disagreed about whether the changes in development patterns and public policies necessary to achieve the high end of these findings are plausible."[77]

In preparing this report, the committee commissioned five background papers. Most of these papers offer little support to those who promote compact development as a way of reducing greenhouse gas emissions.

One paper by University of California economist David Brownstone reviewed the literature on relationships between "the built environment" and driving (as measured by vehicle miles traveled, or VMT). He concluded that there is a "statistically significant link" between the built environment and VMT—but that the available evidence suggests "the size of this link is too small to be useful."[78] Brownstone also wonders "why controlling VMT should be a policy goal," since mobility has a high value and evidence suggests that people respond to higher fuel prices by buying more fuel-efficient cars more than by reducing driving.[79]

A paper by transportation engineer Kara Kockelman (who was also on the TRB committee) and colleagues at the University of Texas reviews alternative means of reducing greenhouse gas emissions. The paper concludes that policies emphasizing higher fuel-economy standards will be much more cost-effective at reducing emissions than land-use policies aimed at reducing driving. In fact, the

**A literature review by University of California economist David Brownstone found that the link between the built environment and driving is "too small to be useful."**

**There is no consensus among researchers about how much compact development would reduce driving, suggesting this is a highly risky proposition.**

paper says, compact development and transit improvements could both substantially *increase* emissions rather than reduce them—the first by increasing congestion (which leads cars to emit more pollution) and the second because transit construction and operations both emit substantial amounts of greenhouse gases.[80]

George Mason University transportation engineer Michael Bronzini wrote a paper on the relationship between land use and truck traffic. He concluded that "low-density development does increase truck traffic" and that "it appears that smart-growth measures could be effective in reducing truck VMT."[81] However, Bronzini did not assess the cost-effectiveness of such measures.

A paper on housing trends by John Pitkin and Dowell Myers seriously questions Arthur Nelson's claims that cities should be substantially rebuilt at higher densities to meet the demand for those densities. "Nelson and others have placed too great an emphasis on changing preferences as the driver of changing development patterns," says the paper. The report found "scant evidence of any net shift of total or elderly population toward central cities," where development is typically denser.[82] Where Nelson projected that changes in tastes would lead to substantial reconstruction of urban areas, Pitkin and Myers expect "lower replacement rates" and more reliance on existing housing.[83] This suggests that government mandates to rebuild urban areas to higher densities will be far more expensive than suggested by compact-city advocates.

A paper by urban planner Genevieve Giuliano and colleagues at UCLA concludes that two-thirds to three-fourths of jobs in modern urban areas are not located either in downtowns or other urban and suburban centers; instead, they are finely dispersed throughout urban areas. This suggests that concentrating employment, one of the goals of compact-city advocates, will be expensive. The paper also expresses doubt that accomplishing this goal will have significant effects on driving.[84]

Taken together, these papers suggest that using compact development to reduce greenhouse emissions is a highly risky proposition. There is no consensus among researchers about how much compact development would reduce driving, and the 25-percent reduction assumed by *Driving and the Built Environment*'s 75-percent scenario is outside the range of literature reviewed by the report. Claims that demand for compact development is increasing also appear overstated, and there are numerous uncertainties about the benefits and costs of such policies as concentrating employment and construction of transit improvements. These risks suggest that all the various compact-development reports are likely to have overstated the benefits and underestimated the costs of compact-city policies.

## Overstating the Benefits

*Growing Cooler* says its policies can reduce the growth rate of driving by 38 percent.[85] *Moving Cooler* says that smart-growth policies can reduce total greenhouse gas emissions by 9 to 15 percent.[86] In fact, a close reading of these and other reports reveals that compact development has minimal effects on driving and greenhouse gas emissions.

- *Growing Cooler* found that building 60 percent of new urban development to compact standards would reduce 2030 carbon dioxide outputs by 79 million tons, or 1.3 percent of current levels.[87]
- *Moving Cooler* was far less optimistic, projecting that building 64 percent of new development to compact standards, including more pedestrian- and bicycle-friendly design and "high-quality transit," would reduce 2030 carbon dioxide outputs by only 22 million tons, or less than 0.4 percent of current emissions.
- *Moving Cooler*'s maximum effort of making 90 percent of new development compact would reduce 2030 greenhouse gas emissions by 0.6 percent, and 2050 emissions by 1.2 percent below current levels.
- *Driving and the Built Environment* projected that building 75 percent of new devel-

opment to twice current densities would reduce 2050 driving by 11 percent, thereby reducing greenhouse gas emissions by, at most, 1.4 percent below current levels.

The similarity between the *Moving Cooler* and *Driving and the Built Environment* estimates disguises a huge debate among urban planners and economists over how much differences in driving are due to the "built environment" and how much are due to "self selection." Many studies have found that people who live in dense, mixed-use areas drive less than people in low-density suburbs, but it is likely that a large part of this is because people who want to drive less choose to live in dense, mixed-use neighborhoods with intensive transit service.

*Growing Cooler* dismissed this concern by citing a literature review of studies of the effects of density and urban design on driving. "Virtually every quantitative study reviewed for this work," the literature review is quoted as saying, "found a statistically significant influence of one or more built environment measures on the travel behavior."[88] *Growing Cooler* neglected to quote the very next sentence of the literature review: "However, the practical importance of that influence was seldom assessed."[89] In other words, "statistically significant" does not mean "large"; it only means "measurable." As David Brownstone's literature review for TRB concluded, the effects themselves are likely to be "too small to be useful" in reducing greenhouse gas emissions.[90]

Even if the effects projected by these reports are realistic, they hardly make the case for implementing compact-development policies. As one reviewer of the TRB report concluded, "increasing population density in metropolitan areas would yield insignificant carbon dioxide reductions."[91] But if they are so insignificant, how can the authors of so many of these reports argue that compact development policies are essential or that they can reduce emissions by 9 to 15 percent?

One way is by conflating compact development with other policies. *Growing Cooler* admits that increasing the cost of auto driving, through taxes and congestion, has a far greater effect on driving than compact development and transit improvements. Moreover, note that *Growing Cooler* does not project that compact development will reduce emissions, only that it reduces the *growth* in driving—and then only by 7.7 percent.

*Moving Cooler*'s claim that "smart growth" could reduce greenhouse emissions by 9 to 15 percent is based on a "bundling" of compact development with other policies, including taxes on existing parking, a freeze on all new parking, HOV lanes, urban nonmotorized zones, and mandates that employers alter their employees' commuting habits.[92] While *Moving Cooler* claims there are synergistic effects between these policies, it never verifies this claim by comparing the implementation of these other policies with and without the compact-development policies.

Compact-development advocates are so intent on seeing their policies implemented that they never objectively assess the cost-effectiveness of those policies by themselves. A careful look reveals that compact-city programs contemplated by these reports could cost Americans trillions of dollars.

## Underestimating the Costs

While advocates of reducing greenhouse gas emissions might argue that every little bit helps, the truth is that it only helps if it is cost-efficient; cost-inefficient investments would effectively crowd out cost-efficient programs and make it more difficult to achieve reduction targets. Yet the cost of compact development is likely to be extremely high.

The *Moving Cooler* report inexplicably claims that compact development will cost a mere $1.5 billion no matter whether 43 percent, 64 percent, or 90 percent of new development is compact. But at least one member of the TRB committee believes costs will be much higher. "It's an enormous amount of effort to achieve a tiny amount of outcome," says Brookings Institution researcher An-

**Compact-development advocates are so intent on seeing their policies implemented that they never objectively assess the cost-effectiveness of those policies, which could cost Americans trillions of dollars.**

**Portland's mayor supports putting 300,000 new residents in high-density developments "within one-quarter mile of all existing and to-be-planned streetcar and light-rail transit stops."**

thony Downs, regarding the TRB 75-percent scenario. "If your principal goal is to reduce fuel emissions, I don't think future growth density is the way to do it."[93]

Here are some of the costs that compact-city mandates will impose on Americans:

- Loss of property rights
- Reduced geographic mobility
- Higher housing costs and lower home-ownership rates
- Higher taxes or reduced urban services to subsidize compact development
- Increased traffic congestion
- Higher consumer costs
- Reduced economic mobility

**Property Rights**

States that have attempted to use compact development to reduce driving have engaged in a substantial amount of coercion, much of which is aimed at limiting the property rights of private landowners. In 1991, Oregon's land-use planning commission required metropolitan planners to use land-use tools to reduce per capita driving by 20 percent.[94] To reach this goal, the state severely limits what private landowners can do in rural areas, while it mandates high-density development on private land in urban areas.

For example, private landowners in rural Oregon are allowed to build a house on their own land only if they own at least 80 acres, they actually farm it, and they earn at least $80,000 per year from farming it. The state's land-use agency is proud that only about 100 homes per year have been built in rural areas since this rule was adopted in 1993.[95] Nearly 98 percent of the state has been zoned "rural" or some similarly restrictive zone.[96]

Meanwhile, about 1.25 percent of the state has been classified as "urban," or inside of an urban-growth boundary. (The remaining 1 percent is zoned "rural residential," meaning 5 to 10 acre minimum lot sizes.) While some cities have expanded their growth boundaries in response to population growth, Portland is instead intent on "growing up, not out." Even where the Portland boundary has been expanded, planners have placed so many obstacles to home construction that it appears the new areas will never be developed.[97]

To accommodate growth without expanding boundaries, Portland-area planners have rezoned dozens of neighborhoods of single-family homes for apartments, using zoning so strict that if someone's house burns down, they will be required to replace it with an apartment.[98] Portland's mayor, Samuel Adams, supports putting all new residents—an estimated 300,000 by 2035—in high-density transit-oriented developments "within one-quarter mile of all existing and to-be-planned streetcar and light-rail transit stops."[99]

Naturally, these sorts of policies generate stiff resistance from rural property owners who do not want their land "downzoned" and urban homeowners who do not want their neighborhoods "densified." Considering the uncertainty about whether compact development can even have a significant effect on greenhouse gas emissions, this sort of controversy is bound to distract attention from the more serious debate over whether, and by how much, emissions should be reduced—a distraction that emissions-reduction advocates should want to avoid.

Compact-city advocates argue that zoning that prevents developers from building apartments in neighborhoods of single-family homes is itself a restriction on property rights that should be lifted. But such zoning was originally put in place to protect property values. In the absence of zoning, developers have found that sale prices are enhanced when they place covenants on properties that prevent the mixture of single-family housing with other uses. Historically, most zoning of undeveloped areas has been responsive to market demand. Once developed, zoning aims to protect existing property values, and as such it is merely an alternative to such covenants. Compact-city zoning is far more prescriptive, often mandating unmarketable changes to existing uses that can significantly reduce property values, at least for the current owners.

A case can be made that zoning restrictions should be relaxed so that developers can meet the market demand for higher-density housing. But relaxing restrictions is very different from imposing tighter restrictions that mandate high-density housing. Even when relaxing restrictions, property owners should be given the opportunity to form homeowner associations that can write protective covenants that will protect their neighborhood's property values, as has been suggested by University of Maryland professor Robert Nelson.[100]

**Mobility**

Americans are the most mobile people on earth, and that mobility is an important part of America's economic well-being. Research has proven that there is a strong correlation between mobility and economic productivity. Regions in which workers can reach more jobs within a 25-minute commute, or employers have access to more workers within 25 minutes, grow faster and provide higher incomes than less mobile regions.[101]

Contrary to implications often made by compact-city advocates, transit is not an adequate substitute for automobility. Even the best public transit systems in the world are slower, reach fewer destinations, and fail to go at all times when automobiles can be available. This is revealed by comparing travel in Europe with that in the United States.

In 2004, the average American traveled more than 15,000 miles by auto, compared with 6,600 miles for the average western European (residents of the fifteen countries in the European Union in 2000). Meanwhile, the average European traveled less than 1,300 miles by bus and rail compared with more than 600 miles by the average American.[102] The 700 additional miles of bus and rail travel hardly make up for the 8,800 fewer miles of auto travel.

When gasoline prices briefly reached $4 per gallon in 2008, numerous media reports indicated that Americans were driving less and taking transit more. Yet the increases in transit usage actually made up for only a tiny percent of the decline in driving. In the second quarter of 2008, for example, Americans traveled 25 billion fewer passenger miles in urban areas by car, but transit ridership grew by only 700 million passenger miles, or less than 3 percent of the drop in urban auto travel.[103]

Even to the extent that transit can replace auto trips, the cost is very high. Counting all capital and operating costs, including subsidies, Americans spend about 24 cents per passenger mile on auto travel.[104] By comparison, urban transit costs an average of 81 cents per passenger mile.[105] Nor is it likely that these costs will decline if transit use increases. More than 40 percent of all American transit ridership is in the New York metropolitan area, but New York transit operating costs per trip or passenger mile are only about 20 percent less than the national average.

**Housing**

Planners create compact cities by using urban-growth boundaries or similar tools that create artificial land shortages. Given the resulting high land prices, higher percentages of home buyers settle for multi-family housing where they might have preferred single family, or settle for small lots where they might have preferred large yards.

In short, compact-development policies greatly increase the costs of all types of housing as well as retail, commercial, and industrial development. States that have required cities to write compact-development plans have significantly less affordable housing than states that do not.[106] Such states also suffered from the worst housing bubbles in the recent financial crisis, while states that did not require such plans tended not to have any bubbles.[107]

Arguably, at least some of these higher costs are a zero-sum game: for every land or homebuyer who must pay more, there is a seller who earns a windfall profit because of the artificial shortage. But at least some of the costs are a deadweight loss to society.

For example, in regions with no urban-growth mandates, cities and counties compete for new development, and the tax revenues that it brings in, by keeping permitting costs low and approval times short. Urban-growth boundaries limit this competition, and cities typically respond by significantly increasing

**Mass transportation is not an adequate substitute for automobility as it tends to be slow and doesn't go where people want to go when they want to go there.**

permit costs and the risk that property owners will never get a permit to build. One study found that such policies increased permitting costs from $10,000 per home in relatively unregulated Dallas to $100,000 per home in San Jose, which adopted compact-development policies in 1974.[108]

Many cities have responded to the housing affordability problems created by their compact-development policies by mandating that developers sell 10 to 20 percent of their homes at below-market prices to low-income buyers. This leads to developers to both raise the price of other homes to make up for the losses on the share they must sell below market and to build fewer homes, which creates further affordability problems.[109]

*Growing Cooler* and *Moving Cooler* rely on Arthur Nelson's estimate that 89 million new or replaced homes will be built between now and 2050.[110] If 80 percent of this construction takes place in metropolitan areas and suffers a deadweight cost of $25,000 per housing unit because of compact-development policies, the cost will reach nearly $1.7 trillion.

Even to the extent that someone gains when others are forced to pay higher prices for homes and land, the economy as a whole loses for several reasons. First, less affordable housing tends to mean lower homeownership rates. Studies show many positive benefits associated with homeownership. For example, children in low-income families that own their own homes do significantly better in school than those in low-income families that rent.[111]

Areas with high rates of rental housing are traditionally associated with higher unemployment rates. But research has found that compact-city policies can reverse this relationship. Artificial shortages of housing increase the costs of selling and moving, and so discourage people who own their own homes from relocating to a city with more jobs.[112]

**By making housing more expensive, compact-development policies are likely to impose a deadweight cost on society of at least $1.7 trillion.**

Urban areas that make themselves unaffordable using compact-city policies end up with dramatically different income distributions from the rest of the country.[113] Low- and even middle-income families are forced to move out, turning the urban area into "Disneyland for yuppies" (as California demographer Hans Johnson put it) or "boutique cities catering only to a small, highly educated elite" (as Harvard economist Edward Glaeser put it).[114] While that might be good for the region's short-term tax revenues, it slows economic growth and reduces the opportunities for economic mobility that are available to low-income families in more affordable housing markets.

**Taxes and Urban Services**

Creating artificial land shortages that boost housing costs is not enough for compact-city planners in many regions. Most cities have supplemented this with subsidies to high-density, mixed-use developments that supposedly reduce driving. The biggest source of these subsidies is probably tax-increment financing, which was discussed under the CCAP report.

Other subsidies include property-tax waivers for favored kinds of development, below-market sales of public land to developers who promise to build at certain densities, and public financing of infrastructure that would otherwise have been built by the developer. Many cities also streamline approval processes and/or waive impact fees for denser developments.

While *Moving Cooler* estimates that the total cost of increasing the density of 90 percent of all new urban development in the United States would be just $1.5 billion, Portland alone has committed nearly this amount in subsidies to developers of high-density projects. The city has committed more than $230 million in subsidies to the famous Pearl District (River District) and nearly $290 million in subsidies to the South Waterfront District (North Macadam), both of which are on the streetcar line; more than $300 million to the Interstate Corridor on the Yellow light-rail line; more than $164 million for the Gateway District on the Blue light-rail line; $75 million for the Lents District on the Green light-rail line; more than $72 million for Airport Way on the Red light-rail line; and $66 million to the Central Eastside District, on a planned streetcar and light-rail line.[115] This only counts tax-increment financed subsidies and not tax waivers, below-market land sales, or other subsidies.

As described above, projects supported through tax-increment financing and property-tax waivers increase the burdens on Portland schools, fire, police, public health, and other programs, but dedicate the taxes that would have gone to those programs to developers instead. The result is that these other programs have seen declines in both the quality and quantity of services they can provide to the rest of the city.

In many cases, Portland subsidies have exceeded $100,000 per housing unit. If subsidies averaging $25,000 per housing unit are applied to 60 percent of the new homes built in metropolitan areas between now and 2050, the total subsidies will exceed $1 trillion. This assumes 89 million new homes built between now and 2050, as estimated by Arthur Nelson, 80 percent of which would be within metropolitan areas. But the Pitkin and Myers paper commissioned for the TRB study calculates that Nelson overestimated the rate of new construction by 50 percent, which means subsidies would have to be even greater to reach compact-development targets.[116]

Combined, the deadweight losses from compact-development regulations and subsidies are likely to exceed $2.8 trillion. If these regulations and subsidies produce the maximum reductions in greenhouse gas emissions projected by *Moving Cooler*, the cost per ton of abated emissions will be nearly $2,000—well above the $50-per-ton cost-effectiveness threshold set by the McKinsey report. Of course, this does not count other costs of compact development, such as congestion and effects on consumer prices.

**Congestion**

Increasing roadway congestion appears to be a deliberate part of compact-city plans. If people cannot easily travel long distances, planners hope, they will be more willing to live in denser developments. In 1996, for example, the Twin Cities Metropolitan Council decided to limit the "expansion of roadways" in the hope that "as traffic congestion builds, alternative travel modes will become more attractive."[117]

Similarly, Portland decided to allow rush-hour congestion to reach "level of service F" (a traffic engineering term meaning stop-and-go traffic) in most of the city's highways. When asked why, transportation planner Andrew Cotugno (who was a member of the TRB committee) responded that relieving congestion "would eliminate transit ridership."[118]

Even if congestion were not a deliberate goal of compact-city planners, it would clearly be a major result of such plans. Using census data, *Moving Cooler* estimated that increasing densities from an average of 3,000 people per square mile by an additional 133 percent to an average of 7,000 people would reduce per capita driving by less than 15 percent.[119] That many more people driving 15-percent less each still means a 100-percent increase in total vehicle miles of travel. Since compact-city planners would oppose any new highways to accommodate that travel, there would obviously be a huge increase in congestion.

Congestion, of course, imposes huge costs on commuters and businesses. It also impacts the environment, as autos in stop-and-go traffic consume far more fuel and emit more pollution and greenhouse gases per mile than autos in free-flowing traffic. In fact, the focus on reducing miles of driving is misguided because miles driven are not proportional to greenhouse gas emissions, since congestion is the leading cause of such disproportionality.

**Consumer Costs**

Compact development advocates often argue that the loss of mobility resulting from less auto driving can be mitigated by increased accessibility from mixing retail and other uses with, or within walking distance of, residential areas. Why drive when you can simply walk downstairs from your condo and go grocery shopping or have a cup of coffee? "Millions of people could be liberated from their vehicles" if neighborhoods were redesigned to make things accessible without requiring mobility,

**Compact development increases traffic congestion because large increases in densities are required to get small reductions in per capita driving.**

argues Robert Cervero (who was on the TRB committee).[120]

This ignores, however, the nature of the modern retail industry. Major supermarkets and other stores can offer a wide variety of low-cost goods only because large numbers of customers can reach them by car. Shrink the pool of customers by limiting them to those within walking distance and costs rise—while the variety of goods offered declines. Prices rise further when people become captives of one store; the competition that exists when people can reach several stores in one short auto trip encourages retailers to adopt innovative programs that reduce costs.

Moreover, like homebuyers, retailers in compact communities will have to pay more for land, adding further to consumer prices. Thus, the higher prices that are typically found in "accessible" versus mobile communities are not a zero-sum game: the retailers are not earning fatter profits; they are merely suffering higher costs due to inefficient management.

**Mobility is a key component of the American dream, and proposals to reduce mobility should be viewed with the same suspicion as proposals to limit freedom of speech or freedom of religion.**

**Economic Mobility**

Several studies have found that auto ownership is a key factor to helping low-income families move into the middle class. One found that people without a high-school diploma were 80 percent more likely to have a job and earned $1,100 more per month if they had a car. In fact, the study found that owning a car was more helpful to getting a job than getting a high-school-equivalent degree.[121] Another study found that closing the black-white auto ownership gap would close nearly half the black-white employment gap.[122]

As a result, numerous analysts have noted that efforts to reduce per capita driving will have their greatest impact on low-income families. "Their most severe effects" of mobility restrictions, says Alan Pisarski, "will fall on those groups that either have recently attained mobility or are just now on the verge of attaining it."[123]

Transit improvements will not make up for this loss in economic mobility. "Public transit is not a reasonable substitute for the private vehicle for most people, poor or not poor," says UCLA planning professor Genevieve Giuliano.[124] For example, an analysis of job accessibility in Cincinnati found that people living in low-income neighborhoods could reach 99 percent of the region's jobs within 20 minutes by car, but only 21 percent of the region's jobs in a 40-minute trip by transit. Furthermore, building light rail, the study found, would actually reduce job accessibility for low-income workers.[125]

Economic mobility is the American dream, and geographic mobility is a key component of that dream. No matter how noble the intentions, proposals to reduce mobility should be viewed with the same suspicion as proposals to reduce freedom of speech or freedom of the press.

## Getting the Prices Right

Compact development is an indirect and risky way of reducing greenhouse gas emissions. It depends on people responding to compact cities in the ways that planners hope; on the assumption that reduced greenhouse gas emissions from reduced driving will not be offset by increased emissions from more driving in stop-and-go traffic; and on planners' faith that the costs of unintended (and intended) consequences such as unaffordable housing, congestion, and reduced worker productivities will not be greater than the benefits.

Those who are skeptical of the need to reduce carbon dioxide emissions should naturally reject compact-city schemes as an unnecessary and expensive imposition on personal freedom and mobility. Those who support policies to reduce carbon dioxide emissions should also reject compact-development programs as risky, cost-ineffective ideas that will divert resources and attention away from genuine emission-reduction programs.

One of the most effective ways of reducing carbon emissions is simply to price them using a revenue-neutral carbon tax whose income is offset by reductions in income or other taxes. Moving Cooler estimates that carbon pricing would be 10 times more effective at reducing auto-related emissions than compact development, and that the vast majority of that reduction would come from people buying more fuel-efficient cars, not driving less.[126]

Carbon pricing would allow people to choose for themselves whether they respond to higher fuel prices by buying more fuel-efficient cars, using alternative fuels, "eco-driving" in a more fuel-efficient manner, or driving less. Those who choose to drive less could also decide whether they want to live in high-density communities or continue to live in low-density communities but adjust other driving habits, perhaps by living closer to work, trip chaining, or shopping at one-stop supercenters instead of several smaller stores.

Carbon pricing would also have more immediate effects on energy use and carbon emissions than compact development, which will take decades to implement. *Moving Cooler* predicts that, in 2020, maximum use of carbon pricing would reduce auto-related emissions more than 30 times as much as maximum use of compact development, while in 2030 it would be 12 times as much.[127]

These more-immediate effects mean that carbon pricing would be easier to evaluate and fine-tune in order to ensure that any emission-reduction targets are met. By comparison, the slow deployment of compact development, combined with the indirect effects it has on driving and carbon emissions, means that decades will pass and hundreds of billions of dollars will be spent before we know if it is even working.

Finally, carbon pricing would not only be easier to implement than compact development, it would affect all producers of carbon emissions, notably including fossil-fuel-powered electrical plants. This means one tool can address far more sources of carbon emissions, while compact development mainly influences urban auto driving, which produces less than 13 percent of greenhouse gases.

No policy is immune to political abuse, and carbon taxes could easily turn into just one more source of pork barrel (as seems to have happened to the recent cap-and-trade proposal). If climate change worries prove baseless, a carbon tax is not even necessary. But for those who insist on reducing carbon emissions, a true, revenue-neutral carbon tax makes far more sense than intrusive government policies aimed at coercing people out of their homes and cars and forcing them to live in politically correct multi-family housing and to ride on politically correct mass transit.

**The Brookings study proposes to save energy by drastically reducing the size of American living spaces.**

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SPECIAL REPORT 298:
DRIVING AND THE BUILT ENVIRONMENT:
THE EFFECTS OF COMPACT DEVELOPMENT ON
MOTORIZED TRAVEL, ENERGY USE, AND $CO_2$ EMISSIONS

# Key Relationships Between the Built Environment and VMT

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# Key Relationships Between the Built Environment and VMT

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## 1 INTRODUCTION

This paper critically examines the current literature on the relationships between the built environment and household vehicle miles traveled (VMT). VMT itself is rarely of direct policy interest, but VMT is an important component of greenhouse gas emissions and congestion. Furthermore, policies designed to address these problems will very likely influence VMT as well. Section 4 addresses some of issues involved when other policies besides the built environment are considered. One important issue that this paper does not address is the cost/benefit tradeoffs comparing using the built environment to control VMT compared to more direct carbon or fuel taxes.

One of the key conclusions from this review is that the magnitude of the link between the built environment and VMT is so small that feasible changes in the built environment will only have negligible impacts on VMT. For example, Brownstone and Golob's (2008) results imply that increasing density by 1000 dwelling units per square mile (roughly 40% of the mean density value in their sample) will decrease a representative household's VMT by 1200 miles per year (approximately 5% of the mean sample value). As Downs (2004, Chapter 12) clearly shows, increasing density of an existing metropolitan area by 40% requires extreme densities of new and infill development. Bryan, Minton, and Sarte (2007) have recently developed a consistent historical database of U.S. city and regional densities. These data show that only 30 out of 456 cities increased population density more than 40% between 1950 and 1990, and the median city in this sample decreased population density by 36%. The cities that did increase population density by more than 40% are similar to Santa Ana, California. They experienced large increases in low-income immigrants into very tight housing markets. The increase in densities in these cities was largely accommodated by cramming more people into the existing housing stock. This suggests that more direct fuel and congestion taxes will be more effective for controlling vehicle emissions and congestion.

My standards for accepting empirical conclusions from the literature reviewed here are strict. I only consider results that I would be willing to personally recommend to my local planning agency and defend in the inevitable lawsuits that accompany controversial public policy positions. Studies that were reviewed and not discussed in this paper are listed in the Appendix. This standard makes it difficult to find any reliable quantitative estimates of key elasticities. Many studies are based on aggregate data and therefore subject to self-selection bias described in Section 2. Other studies based on disaggregate data typically include nonlinear discrete choice models but only report coefficient estimates and/or elasticities calculated at mean values of the household explanatory variables. This information is simply not sufficient to judge whether the elasticities are statistically significant and/or large enough in magnitude to be useful for policy purposes. Many studies are only concerned with finding statistically significant effects without any attempt to check whether the precisely estimated coefficients are large enough to be relevant for policymakers. Fang (2008) is a good example of the types of calculations needed to judge policy relevance for these models.

Another important problem with the literature reviewed here is that there is little agreement on what aspects of the built environment are important determinants of VMT. Even when two authors agree on these aspects, they frequently quantify these aspects in different ways that make comparisons across papers difficult. It has also been difficult to get data on many potentially important aspects of the built environment. Therefore many studies just use data from one metropolitan area. This makes it difficult to generalize the results of these studies beyond the particular area studied, so I have given more weight to those studies using nationally representative data. Section 3 addresses these issues.

## 2 SELF-SELECTION

The most important methodological issue for all studies reviewed in this paper is the self-selection issue. Households choose their residential (and work) locations based, among other things, on their preferences for different types and durations of travel. The observed correlations between higher density and lower VMT may just be due to the fact that people who choose to live in higher density neighborhoods are also those that prefer lower VMT and more transit or non-motorized travel. If this is the case, then forcing higher densities may not lead to anywhere near the reduction in VMT "predicted" by observed correlations.

The "gold standard" for solving self-selection problems is to conduct randomized assignment to treatment and control groups. In the context of the links between the built environment and VMT, then this would require randomly assigning households to different neighborhoods and then observing differences in their VMT. Of course this is rarely possible, so various econometric techniques have been employed to try to correct for this problem.

Aggregate studies that just look at bivariate relationships (e.g. Newman and Kenworthy, 1999) typically make no attempt to control for self-selection, so they are the least reliable. Other studies (e.g. Holtzclaw, et. al., 2002) use aggregate sociodemographic variables to try to control for population differences across different zones. Unfortunately the zones used in Holtzclaw et. al. are quite large with an average size of 7000 residents per zone, and there are only limited sociodemographic data available at the zonal level. Most importantly, there are no data on the variability of things like household size and income within each zone. At least for Los Angeles in 2000, the variation of variables like average household income and average household size across traffic analysis zones is a small fraction of the variation of household income and household size for the Los Angeles MSA. Holtzclaw et. al. use smog check odometer readings to get VMT for their zones, but since California exempts new vehicles from smog checks for the first 2 years, this measure systematically biases VMT downwards for zones with large numbers of new vehicles.

Many studies with disaggregate data attempt to control for observable differences between people living in high and low density areas using regression methods. These studies are only valid to the extent that these people differ only on observable characteristics. Therefore studies like Bento et. al. (2005) which includes a rich set of household socioeconomic characteristics should be less affected by self-selection bias.

Finally there are a few more recent studies that jointly model residential location (or at least density) and VMT. These joint models require a lot of assumptions, but if the assumptions are valid then they properly control for self-selection bias. One source of confusion in the literature is the role of instrumental variables, an old econometric technique to deal with endogenous explanatory variables in linear regression models. Boarnet and Sarmiento (1998) were among the first to use instrumental variables to deal with the endogeneity of residential density (caused by self selection) in regressions explaining VMT. More recently Vance and Hedel (2007) used instrumental variables in a two-stage model of car use and VMT conditional on car use. There is frequently an implicit claim that instrumental variables is preferable to explicit joint modeling of density and VMT since instrumental variables makes no explicit assumptions about the variables explaining density, but in fact the requirements for a valid instrumental variable are identical to those required to identify a joint linear model. In particular, a valid instrument must be strongly correlated with density but uncorrelated with car VMT.

Boarnet and Sarmiento (1998) found no stable link between density and VMT after using instrumental variables to control for the endogeneity of density. However, Vance and Hedel (2007) found significant links between commercial density, road density, and walking minutes to public transit and car VMT using similar instruments to Boarnet and Sarmiento (the percentage of buildings built before 1945, the percentage of buildings built between 1945 and 1985, the percentage of residents more than 65 years old, and the percentage of foreign residents). Vance and Hedel did many tests of the validity of these instruments, so the likely reason is differences between the German panel data and the U.S. data used by Boarnet and Sarmiento. Another possible reason is that German cities tend to be denser and have much better transit than U.S. cities, so U.S. cities may not offer enough transit to be a viable alternative to private cars. For example, roughly 30% of the trips recorded in the German travel diaries did not use private cars.

There have been a number of papers explicitly modeling residential location choice and VMT. Brownstone and Golob (2008) build a simultaneous equations model of households' choice of residential density, VMT, and vehicle fuel use using the 2001 National Highway Transportation Survey. Conditional on a rich set of socioeconomic covariates, they find that residential density choice is not determined by VMT or fuel use, but does influence VMT and fuel use. The magnitude of this effect is very small, which suggests that feasible changes in residential density will not have any important effect on VMT or fuel use. The error terms in the estimated system are independent, implying no self-selection bias conditional on the covariates. However, removing any of the covariates from the model leads to self-selection bias which shows the importance of using household level data.

Zhou and Kockelman (2007) use Heckman's treatment-effects model to account for self-selection between CBD and non-CBD in Austin, Texas. They find little impact of self-selection – about 90% of the observed differences in VMT are due to the treatment effect (living in the CBD). Unfortunately the variable they use to identify the system, the number of visitors to the household on the survey day, is quite weak. It is weakly correlated with the decision to live in the CBD, and it is not clear why it can be excluded from variables explaining VMT on the survey day.

Bhat and Guo (2007) build an ambitious model using San Francisco Bay Area data to build a joint model of residential location and number of household vehicles. Their model allows for self-selection effects (correlation between the error terms in their equations), but after controlling for a rich set of covariates they do not find any significant self-selection effects. Similar to Brownstone and Golob (2008), Bhat and Guo find statistically significant but quantitatively small impacts of built environment measures (street block density, transit availability, and transit access time) in vehicle ownership. Bhat and Guo were able to include a large number of covariates in their models since they only worked with one metropolitan area. The only variable that frequently appears in residential choice models that is missing in Bhat and Guo's model is school quality, but that is probably highly correlated with zonal income and zonal housing values which are included in their model.

There are also a number of studies which deal with self-selection by trying to directly measure preferences through attitude surveys (Kitamura et. al., 1997 and Bagley and Moktarian, 2002, and Frank et. al., 2007). These studies typically find that attitudes explain most of the variation in VMT across households, and the regression model fits (as measured by $R^2$) improve significantly relative to models without attitude measures. The most likely reason for the greatly improved fit is that the attitudes are jointly determined by the outcome variables. People who live in dense urban areas tend to express positive attitudes about urban characteristics, and people who commute long distances are likely to express positive attitudes about large lots and open spaces. If this is the case then these attitudes cannot be treated as exogenous and stable, and their inclusion in models will bias all of the results. It is also possible that the measured attitudes will change with the built environment, and this would invalidate the results from these models.

Krizek (2003) attempts to control for self-selection by looking at changes in travel behavior for households that moved between consecutive years in the Puget Sound Transportation Panel Study. This approach is only valid if households only move for reasons that are unrelated to their preferred type of neighborhood, such as to change jobs or accommodate a change in household size. If a household moves because they were dissatisfied with the characteristics of their initial neighborhood, then Krizek's analysis of movers would be invalid. Looking at changes in panel surveys has become the standard approach to self-selection problems in labor economics (see Heckman and Vytlacil, 2007), but these methods require massive data sets and complex methodology. For example, Krizek considered 6,144 households over 10 years of the panel, but only observed 403 households that moved. Since some of these households moved because of changes in household composition, it is sometimes not clear how to define the household across these moves. Nevertheless using modern dynamic panel data methods and collecting the required panel data is the best way to finally resolve the self-selection issue.

Recent studies with disaggregate data find no impact of self-selection after controlling for rich sociodemographics. This suggests that it is critical to carefully control for sociodemographics when building models of household VMT, and therefore results from studies using aggregate data are likely subject to serious self-selection biases. Although recent studies use state-of-the-art methods, they all have weaknesses in the scope and accuracy of the underlying data. In particular, there is little agreement on the geographic scope or the definition of appropriate measures of the built environment. It is therefore possible that studies using different measures may find significant impacts of self-selection.

## 3 KEY FEATURES OF BUILT ENVIRONMENT

There are potentially many aspects of the built environment that could affect households' travel behavior. Naturally research has concentrated on those aspects that are easy to measure. Since most measures of the built environment are highly correlated, it may only be necessary to include a few key characteristics to capture the effects. Most national level studies only use residential and/or employment density since these are the easiest to obtain. One study that put a lot of effort into measuring various aspects of the built environment is Bento et. al. (2005). They generated measures of road density, rail and bus transit supply, population centrality, city shape, jobs-housing balance, population density, land area, and climate and merged these with 1990 NPTS survey respondents living in MSAs. They found that their measure of population centrality was a significant factor explaining vehicle ownership, but not a significant factor explaining VMT conditional on vehicle ownership. Consistent with other recent studies using disaggregate data, Bento et. al. (2005) found that the magnitude of the impact of any of their built environment measures was too small to support any policy relevance. They concluded their paper with some simulations using their estimated model to examine the counterfactual experiment of "moving" people from Atlanta to Boston. Even though the impact of any single built environment factor is small, the cumulative impact of changing many factors is sufficient to explain the observed differences in VMT between the two cities. Of course, the cost of making Atlanta look like Boston is prohibitive.

Ewing and Cervero (2001) conducted an extensive review of the literature on the links between travel and the built environment. They argue that elasticities are the best way to summarize the quantitative conclusions from these sorts of studies, and they built an extensive table (Table 8) giving average elasticities for many of the best studies. Even though these elasticities for the nonlinear models are incorrect (they need to be averaged over the sample, not simply evaluated at sample means of the explanatory variables), the numbers in Table 8 are mostly all below 0.1 in absolute value. Standard errors are not provided, but it is likely that the hypothesis that they are all equal to zero cannot be rejected. The largest elasticities (around 0.3) are reported for regional accessibility measures, but as the discussants pointed out these measures are very difficult to change with feasible zoning/planning tools. Ewing and Cervero (2001) also provide a summary table (Table 9) showing that elasticities of vehicle trips and VMT with respect to density, diversity, and local design are all below 0.05.

Badoe and Miller (2000) also surveyed the literature on the interactions between land use and transportation. They tend to be more critical of the existing literature, and mainly conclude that most studies they surveyed suffered from methodological and/or data weaknesses. Their tables also show that regional accessibility measures are important, and they stressed the importance of socioeconomics as determinants of travel behavior. The best way to incorporate socioeconomic impacts is to use household level data, but Badoe and Miller point out that using these disaggregate models for forecasting then requires very detailed forecasts of the socioeconomic variables.

Given that there is no clear consensus about which feasible measures of attributes of the built environment are important, it is almost certain that all of the studies reviewed in the paper suffer from measurement error. If this measurement error is large, then the coefficients on these variables will be biased downwards. Although this could explain the inability of most studies to find substantively and statistically significant links between the built environment and VMT, the main impact of measurement error is to increase the variability of the coefficient estimates. Since recent studies using disaggregate data have found statistically significant but substantially very small links between some aspects of the built environment and VMT, it is likely that measurement error is not the main problem.

Another possible reason for the weak links between the built environment and VMT is that there are non-linearities in the relationship, and the U.S. data is primarily in the range where density and other aspects do not have much impact. Some aggregate studies (Newman and

Kenworthy, 1996 and 2006) including foreign cities have found evidence of these non-linearities (or "inflection points"), but as discussed in Section 2 these studies are subject to serious self-selection biases. In particular, many dense foreign cities have much lower incomes and therefore much lower automobile ownership rates than in the U.S. This is a more likely explanation of the inflection point found in these aggregate studies.

## 4 OTHER POLICIES THAT AFFECT VMT

It is not clear why controlling VMT should be a policy goal. The worldwide spread of the private automobile (and VMT) shows that people place a high value on increased mobility. Vehicle use is associated with externalities – especially polluting emissions and congestion, and economists have long advocated using Pigouvian taxes as a more efficient policy tool to deal with these problems. Given current technology, taxing greenhouse gas emissions is equivalent to taxing gasoline. The best recent studies (see Small and Van Dender, 2007) suggest that raising gasoline taxes will reduce emissions primarily by inducing people to buy more efficient vehicles. Given current U.S. incomes and gasoline price levels, VMT is not strongly affected by modest tax increases. Larger gasoline tax increases are beyond the range of observed data, but we can speculate that they would have a direct impact on VMT and also a longer-term impact on the built environment.

Households attempting to lower their VMT will try to move residences and/or job locations. This will impact land rents and the demand for public transit (as well as better bicycle and walking facilities), and may in the end accomplish the same types of changes in the built environment advocated by "smart growth" proponents.

Congestion taxes directly tax VMT in certain locations, and are also likely to provide incentives for households to move to reduce their tax bills. The exact impact of congestion taxes depends on their implementation. For example the London toll ring has increased the demand for housing inside the ring, since tolls are only collected at the ring boundaries. HOT facilities similar to the SR91 and I-15 corridors in Southern California may induce lower income households (who are more sensitive to the tolls) to move closer to their job locations.

Although it is simple to increase fuel taxes, implementing optimal congestion taxes can be technically difficult and costly. Fortunately parking charges can be used together with simple cordon congestion pricing schemes to come close to what could be achieved with optimal pricing (see Calthrop, Proost, and Van Dender, 2000). Of course deliberately restricting parking and/or deliberately under-sizing roads to create congestion are also effective at reducing local VMT, but these can never be as efficient as pricing. If parking is restricted then it is possible that congestion and VMT will increase as drivers search for available parking spaces. These negative impacts can be somewhat mitigated by better information. For example, Lucerne, Switzerland, has large electronic information signs at all of the entrances to the city center showing the number of free parking spaces in all of the main parking garages.

Fuel and congestion taxes and parking fees all have the advantage that they work much faster than we could feasibly change the built environment, and there is no doubt that they will reduce emissions and congestion. In order to be effective these taxes will need to be high enough to generate substantial revenue, and some of this revenue could be used to improve transit service (as was done in London).

## 5 CONCLUSIONS AND DIRECTIONS FOR FUTURE RESEARCH

There are not enough reliable studies that control for enough socioeconomic characteristics to avoid self-selection bias, cover a representative sample of households and geographic area, and use common measures of built environment to support strong quantitative conclusions. There is evidence that there is a statistically significant link between aspects of the built environment correlated with density and VMT. Very few studies provide enough detail to judge whether this link is large enough to make manipulating the built environment a feasible tool for controlling VMT, but those that do suggest that the size of this link is too small to be useful.

Almost all of the studies surveyed in this paper are cross-sectional analyses from the last 2-3 decades, so the conclusions drawn from these studies are only valid to the extent that common background variables do not change. The most obvious problem is energy prices, which have recently almost doubled from their previous stable levels. If these high energy prices persist or a serious carbon tax is imposed, then households will adjust by reducing their VMT, moving to denser neighborhoods, increasing utilization of mass transit, and changing work locations. Existing studies also cannot account for the possible impacts of new travel demand management measures like congestion pricing. Putting a toll ring around a major city (as London has recently done) will cause households to switch to transit and possibly move to more dense neighborhoods. Small (2005) points out that congestion pricing can greatly improve bus service (by improving bus speeds), and this synergistic effect will further shift more households to transit. The only other study that looks at this issue is Cambridge Systematics Inc. (1990), but this only considers large suburban activity centers. The existing detailed disaggregate models can simulate the impacts of an ageing population and continued immigration, but this requires good forecasts of the underlying sociodemographic variables.

The built environment influences far more than just VMT, so a full analysis of the impacts of the built environment must consider all possible outcomes. The literature suggests that density and diversity are correlated with more walking and bicycle trips, which in turn may reduce obesity (see Frank et. al., 2007). There is also evidence that density has a quantitatively small impact on the number and types of vehicles owned by households. However, it is important to remember that there are many reasons for the decreases in residential density and increases in VMT over at least the last 50 years. Some of this may be caused by failure to properly price the externalities associated with vehicle usage, but some of it is also due to household's preferences. Unless justified by some market failure, policies that force people into higher density areas will very likely reduce welfare (see Brueckner, 2001 and Bento and Franco, 2006).

My review of this literature does have implications for future research. The most obvious and non-controversial is that we need better data. In particular we need good samples from the relevant population that contain accurate and detailed data on household socioeconomics, travel behavior, and built environment measures. Travel behavior data should be collected using GPS data loggers, since diary collection is burdensome and leads to missing and inaccurate observations. Since many policies work at least partially by altering the number and types of vehicles, it is also crucial to obtain detailed make/model information for all household vehicles (as in the 2001 NHTS survey). Built environment data also needs to be collected in a uniform fashion across geographic areas. This would be much easier if metropolitan planning agencies could agree on definitions and collection methods for key variables. This effort could be helped by coordination and possibly some money from the U.S. Department of Transportation.

Section 2 of this paper highlighted the problems caused by self selection. This implies that there is not much use in continuing to study the links between the built environment and transportation behavior using aggregate data. Another implication of the literature reviewed in Section 2 is that transportation behavior is strongly correlated (and probably caused by) households' socioeconomic characteristics. This implies that using disaggregate models for forecasting requires forecasting socioeconomic characteristics. This difficult task is made even harder by that changes caused by immigration and aging will lead to changes in the built environment and possibly changes in the built environment will cause migration that will alter the socioeconomic makeup of the city. The best way to study these important issues is to collect panel data that follow households over time. These data are very expensive, and the only examples I could find are the German Panel data used by Vance and Hedel (2007) and the Puget Sound Panel Study used by Krizek (2003). A more feasible option would be to try to include transportation behavior questions in an existing U.S. panel study like the Michigan Panel Study of Income Dynamics.

Even though Vance and Hedel (2007) and Krizek (2003) had panel data, they did not exploit the potential of panel data to analyze the dynamics of household responses to changes in prices and built environment. These panels are probably too short (10 years) to observe many changes in the built environment, but hopefully they will continue the panels and eventually this will enable very interesting research.

Finally, many studies (especially more recent ones using complex models) simply do not provide enough information to judge whether their results are useful for policy analysis. Many studies only give tables of parameter estimates which typically can only be used to find out the sign and statistical significance of a variable. Some studies give elasticities, but these are typically evaluated at the means of the "exogenous" variables and almost never include any measures of statistical significance. Hopefully editors and referees will be more careful about requiring more thorough description of model output.

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## 7 APPENDIX: STUDIES NOT EXPLICITLY CITED

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# Environmental assessment of passenger transportation should include infrastructure and supply chains

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**Abstract**
To appropriately mitigate environmental impacts from transportation, it is necessary for decision makers to consider the life-cycle energy use and emissions. Most current decision-making relies on analysis at the tailpipe, ignoring vehicle production, infrastructure provision, and fuel production required for support. We present results of a comprehensive life-cycle energy, greenhouse gas emissions, and selected criteria air pollutant emissions inventory for automobiles, buses, trains, and airplanes in the US, including vehicles, infrastructure, fuel production, and supply chains. We find that total life-cycle energy inputs and greenhouse gas emissions contribute an additional 63% for onroad, 155% for rail, and 31% for air systems over vehicle tailpipe operation. Inventorying criteria air pollutants shows that vehicle non-operational components often dominate total emissions. Life-cycle criteria air pollutant emissions are between 1.1 and 800 times larger than vehicle operation. Ranges in passenger occupancy can easily change the relative performance of modes.

**Keywords:** passenger transportation, life-cycle assessment, cars, autos, buses, trains, rail, aircraft, planes, energy, fuel, emissions, greenhouse gas, criteria air pollutants

S Supplementary data are available from stacks.iop.org/ERL/4/024008

## 1. Background

Passenger transportation's energy requirements and emissions are receiving more and more scrutiny as concern for energy security, global warming, and human health impacts grows. Passenger transportation is responsible for 20% of US energy consumption (approximately 5% of global consumption) and combustion emissions are strongly positively correlated [1]. The potentially massive impacts of securing petroleum resources, climate change, human health, and equity issues associated with transportation emissions have accelerated discussions about transportation environmental policy.

Governmental policy has historically relied on energy and emission analysis of automobiles, buses, trains, and aircraft at their tailpipe, ignoring vehicle production and maintenance, infrastructure provision and fuel production requirements to support these modes. Such is the case with CAFE and aircraft emission standards which target vehicle operation only [2, 3]. Recently, decision-making bodies have started to look to life-cycle assessments (LCA) for critical inputs, typically related to transportation fuels [4, 5]. In order to effectively mitigate environmental impacts from transportation modes, life-cycle environmental performance should be considered including both the direct and indirect processes and services required to operate the vehicle. This includes raw materials extraction, manufacturing, construction, operation, maintenance, and end of life of vehicles, infrastructure, and fuels. Decisions should not be made based on partial data acting as indicators for whole system performance.

To date, a comprehensive LCA of passenger transportation in the US has not been completed. Several studies and

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models analyze a single mode, particular externalities, or specific phases, but none have performed a complete LCA of multiple modes including vehicle, infrastructure, and fuel inventories for energy consumption, greenhouse gas emissions, and criteria air pollutant emissions incorporating supply chains [6–9]. The automobile has received the greatest attention while buses, rail, and air have received little focus. A review of environmental literature related to the three modal categories is shown in table S1 of the supporting information (SI) (available at stacks.iop.org/ERL/4/024008).

## 2. Methodology

Onroad, rail, and air travel are inventoried to determine energy consumption, greenhouse gas (GHG) emissions, and criteria air pollutant (CAP) emissions (excluding PM, lead, and ozone due to lack of data). The onroad systems include three automobiles and two urban buses (off-peak and peak). A sedan (2005 Toyota Camry), SUV (2005 Chevrolet Trailblazer), and pickup (2005 Ford F-150) are chosen to represent the range in the US automobile fleet and critical performance characteristics [10–12]. 83% of rail passenger kilometers are performed by metropolitan systems (with Amtrak serving the remaining) [1]. The generalized rail modes (heavy rail electric metro, heavy rail diesel commuter transit, and light rail transit (LRT)) are chosen to capture the gamut of physical size, fuel input, and service niche. The metro and commuter rail are modeled after the San Francisco Bay Area's (SFBA) Bay Area Rapid Transit and Caltrain while the LRT modes are modeled after San Francisco's (SF) Muni Metro and the Boston Green Line. Air modes are evaluated by small (Embraer 145), midsize (Boeing 737) and large (Boeing 747) aircraft to represent the range of impacts from aircraft sizes, passenger occupancy, and short to long haul segment performance [13]. An extended discussion of the characteristics and representativeness of the modes selected is found in the SI. US average data are used for all onroad and air mode components and particular geographic operating conditions are not captured [14, 15]. Rail operational performance is determined from specific systems [15–18].

A hybrid LCA model was employed for this analysis [19]. The use of this LCA approach is discussed in the SI and detailed extensively in [20]. The life-cycle phases included are shown in table 1. The components are evaluated from the materials extraction through the use phase including supply chains. For example, the manufacturing of an automobile includes the energy and emissions from extraction of raw materials such as iron ore for steel through the assembly of that steel in the vehicle. End-of-life phases are not included due to the complexities of evaluating waste management options and material reuse. Indirect impacts are included, i.e., the energy and emissions resulting from the support infrastructure of a process or product, such as electricity generation for automobile manufacturing.

For each component in the mode's life cycle, environmental performance is calculated and then normalized per passenger-kilometer-traveled (PKT). The energy inputs and emissions from that component may have occurred annually (such as from electricity generation for train propulsion) or over the component's lifetime (such as train station construction) and are normalized appropriately. Detailed analyses and data used for normalization are found in [20], including mode-specific adjustments (such as the removal of freight and mail attributions from passenger air travel). Equation (1) provides the generalized formula for determining component energy or emissions.

$$E_M = \sum_{c}^{C} \frac{\mathrm{EF}_{M,c} \times U_{M,c}(t)}{\mathrm{PKT}_M(t)} \tag{1}$$

where $E_M$ is total energy or emissions per PKT for mode $M$;
$M$ is the set of modes {sedan, train, aircraft, etc};
$c$ is vehicle, infrastructure, or fuel life-cycle component;
EF is environmental (energy or emission) factor for component $c$;
$U$ is activity resulting in EF for component $c$;
PKT is PKT performed by mode $M$ during time $t$ for component $c$.

The fundamental environmental factors used for determining a component's energy and emissions come from a variety of sources. They are detailed in SI tables S2–S4 (available at stacks.iop.org/ERL/4/024008). Further, each component's modeling details are discussed in [20] which provides the specific mathematical framework used as well as extensive documentation of data sources and other parameters (such as component lifetimes and mode vehicle and passenger kilometers traveled). Parameter uncertainty is also evaluated in the SI.

Results for modal average occupancy per-PKT performance are reported. While understanding of marginal performance is necessary for transportation planners to evaluate the additional cost of a PKT given a vested infrastructure and the assumption that many public transit trips will occur regardless, the average performance characteristics allow for the total environmental inventorying of a system over its lifetime.

## 3. Results and component comparisons

With 79 components evaluated across the modes, the groupings in table 1 are used to report and discuss inventory results.

### 3.1. Energy

The energy inputs for the different systems range from direct fossil fuel use such as gasoline, diesel, and jet fuel to indirect fossil fuel use in electricity generation. The non-operational vehicle phases use a combination of energy inputs for direct and indirect requirements. For example, the construction of an airport runway requires direct energy to transport and place the concrete and indirect energy to extract and process the raw materials. Figure 1 shows total energy inputs for each mode.

While tailpipe components account for a large portion of modal life-cycle energy consumption, auto and bus non-operational components have non-negligible results. Active operation accounts for 65–74% of onroad, 24–39% of rail, and 69–79% of air travel life-cycle energy. Inactive operation accounts for 3% of bus, 7–21% of rail, and 2–14% of air

**Table 1.** Analysis components (for each component, energy inputs and emissions are determined. The components are shown by generalized mode, but evaluated independently for each system).

| Grouping | Automobiles and buses | Rail | Air |
|---|---|---|---|
| *Vehicles* | | | |
| | | Operational components | |
| Active operation | • Running<br>• Cold start | • Running | • Take off<br>• Climb out<br>• Cruise<br>• Approach<br>• Landing |
| Inactive operation | • Idling | • Idling<br>• Auxiliaries (HVAC and lighting) | • Auxiliary power unit operation<br>• Startup<br>• Taxi out<br>• Taxi in |
| | | Non-operational components | |
| Manufacturing (facility construction excluded) | • Vehicle manufacturing<br>• Engine manufacturing | • Train manufacturing<br>• Propulsion system manufacturing | • Aircraft manufacturing<br>• Engine manufacturing |
| Maintenance | • Vehicle maintenance<br>• Tire replacement | • Train maintenance<br>• Train cleaning<br>• Flooring replacement | • Aircraft maintenance<br>• Engine maintenance |
| Insurance | • Vehicle liability | • Crew health and benefits<br>• Train liability | • Crew health and benefits<br>• Aircraft liability |
| *Infrastructure* | | | |
| Construction | • Roadway construction | • Station construction<br>• Track construction | • Airport construction<br>• Runway/taxiway/tarmac construction |
| Operation | • Roadway lighting<br>• Herbicide spraying<br>• Roadway salting | • Station lighting<br>• Escalators<br>• Train control<br>• Station parking lighting<br>• Station miscellaneous (e.g., other electrical equipment) | • Runway lighting<br>• Deicing fluid production<br>• Ground support equipment operation |
| Maintenance | • Roadway maintenance | • Station maintenance<br>• Station cleaning | • Airport maintenance |
| Parking | • Roadside, surface lot, and parking garage parking | • Station parking | • Airport parking |
| Insurance | | • Non-crew health insurance and benefits<br>• Infrastructure liability insurance | • Non-crew health and benefits<br>• Infrastructure liability |
| *Fuels* | | | |
| Production | • Gasoline and diesel fuel refining and distribution (includes through fuel truck delivery stopping at fuel station. Service station construction and operation is excluded) | • Train electricity generation<br>• Train diesel fuel refining and distribution (Caltrain)<br>• Train electricity transmission and distribution losses<br>• Infrastructure electricity production<br>• Infrastructure electricity transmission and distribution losses | • Jet fuel refining and distribution |

modes. The automobile and bus non-operational components are dominated by electricity production, steel production, and truck and air transport of materials in vehicle manufacturing and maintenance [20]. The construction of the US road and highway infrastructure has large energy implications (in material extraction, material production, and construction operations), between 0.3 and 0.4 MJ/PKT for autos [21–23].

Rail modes have the smallest fraction of operational to total energy due to their low electricity requirements per PKT relative to their large supporting infrastructures [20]. The construction and operation of rail mode infrastructure results in total energy requirements about twice that of operational.

Aircraft have the largest operational to total life-cycle energy ratios due to their large fuel requirements per PKT and relatively small infrastructure. The active and inactive operational groupings include several components (table 1) and energy consumption is dominated by the cruise phase [24, 25].

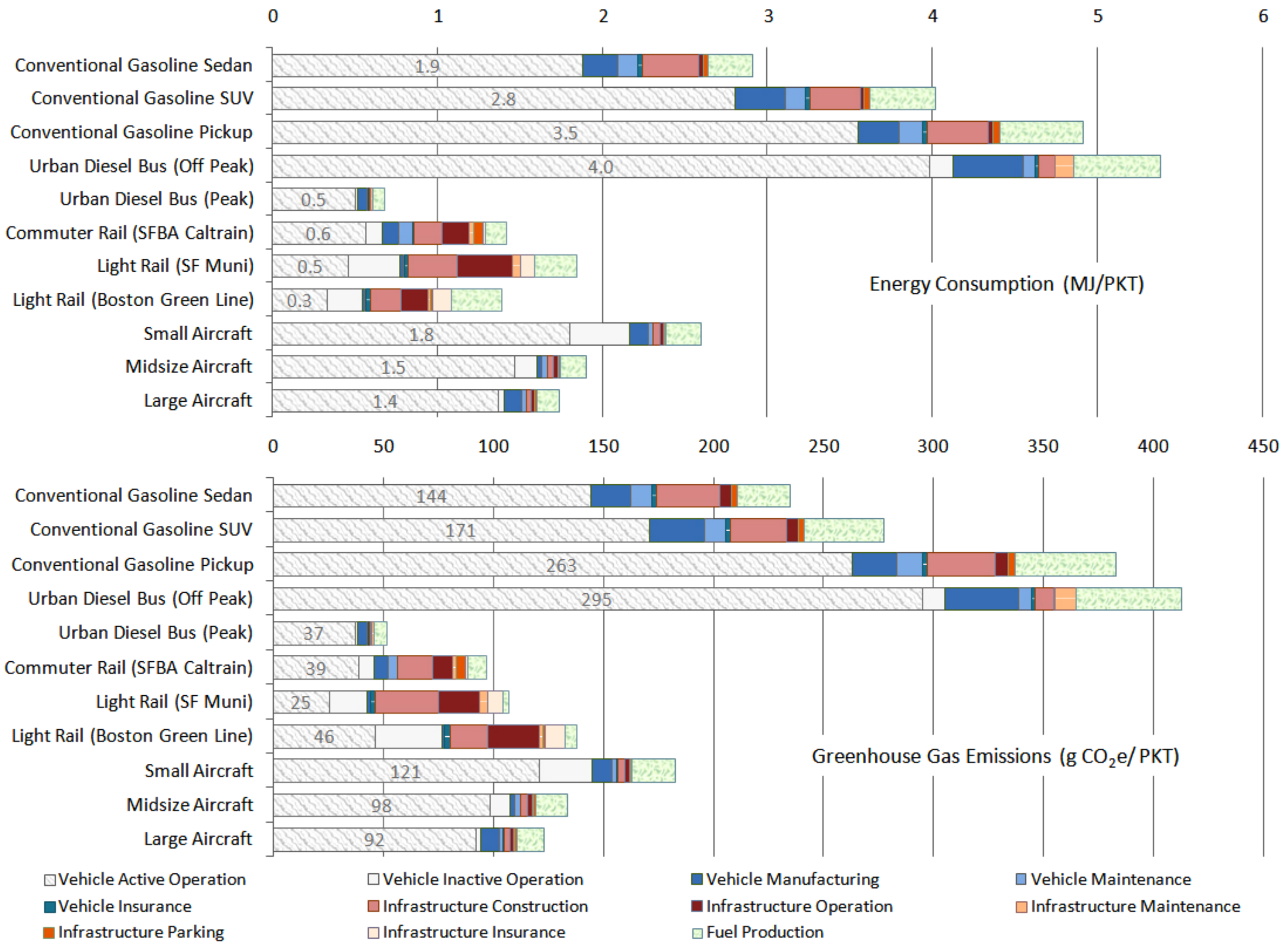


**Figure 1.** Energy consumption and GHG emissions per PKT (The vehicle operation components are shown with gray patterns. Other vehicle components are shown in shades of blue. Infrastructure components are shown in shades of red and orange. The fuel production component is shown in green. All components appear in the order they are shown in the legend.).

### *3.2. Greenhouse gases*

The energy inputs described are heavily dominated by fossil fuels resulting in a strong positive correlation with GHG emissions. The life-cycle component contributions are roughly the same as the GHG contributions and produce 1.4–1.6 times larger life-cycle factors for onroad, 1.8–2.5 times for rail, and 1.2–1.3 times for air than the operational components. Total emissions for each mode are shown in figure 1.

While the energy input to GHG emissions correlation holds for almost all modes, there is a more pronounced effect between the California (CA) and Massachusetts (MA) LRT systems. The San Francisco Bay Area's electricity is 49% fossil fuel-based and Massachusetts's is 82% [26, 27]. The result is that the Massachusetts LRT, which is the lowest operational energy user and roughly equivalent in life-cycle energy use to the other rail modes, is the largest GHG emitter.

### *3.3. Criteria air pollutants*

Figure 2 shows $SO_2$, $NO_X$, and CO emissions for each life-cycle component. The inclusion of non-operational components can lead to an order of magnitude larger emission factor for total emissions relative to operational emissions.

*3.3.1. $SO_2$ contributors.* Electricity generation $SO_2$ emissions dominate life-cycle component contributions for all modes. While electric rail modes have large contributions from vehicle operation components, this is not the case for autos, buses and commuter rail due to the removal of sulfur from gasoline and diesel fuels. Low sulfur levels in fuels result in low $SO_2$ emissions from fuel combustion compared to the relatively large $SO_2$ emissions from electricity generation in other components. Total automobile $SO_2$ emissions are 19–26 times larger than operational emissions and are due to vehicle manufacturing and maintenance, roadway construction and operation (particularly lighting), parking construction, and gasoline production. The electricity requirements in vehicle manufacturing, vehicle maintenance, roadway lighting, road material production, and fuel production (as well as off-gasing) result in significant $SO_2$ contributions [20, 21, 26, 28]. Bus emissions are dominated by vehicle manufacturing, roadway maintenance [21], and fuel production. Vehicle manufacturing, infrastructure construction, infrastructure operation, parking, insurance, and fuel production produce emission factors for rail modes that are 2–800 times (assuming Tier 2 standards) larger than operational components. The majority of vehicle manufacturing emissions result from direct electricity

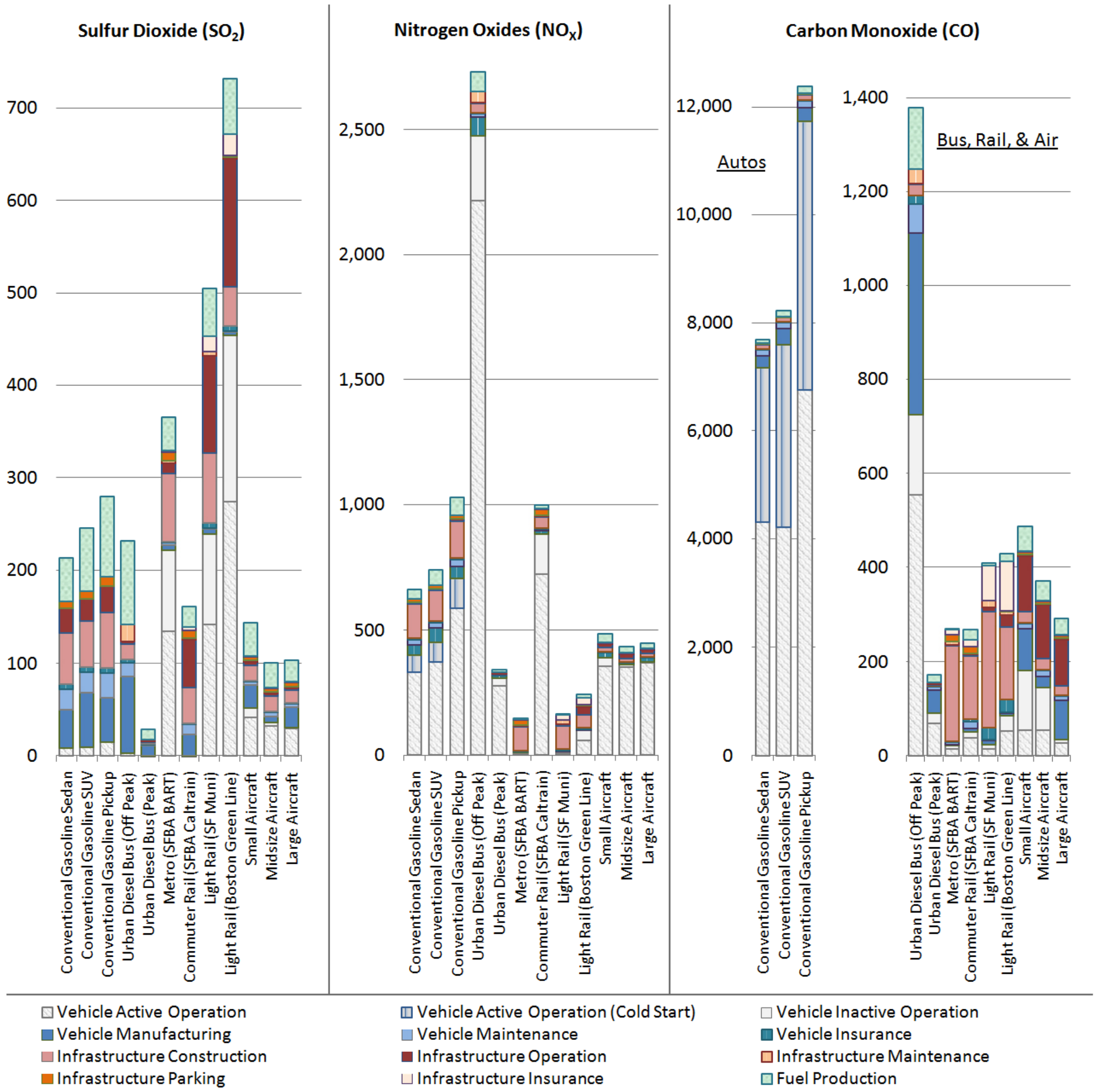


**Figure 2.** Criteria air pollutant emissions in mg per PKT (The vehicle operation components are shown with gray patterns. Other vehicle components are shown in shades of blue. Infrastructure components are shown in shades of red and orange. The fuel production component is shown in green. All components appear in the order they are shown in the legend.).

requirements in assembling the parts as well as the energy requirements to produce steel and aluminum for trains. Total aircraft $SO_2$ emissions are composed of 64–71% non-operational emissions, and are attributed mostly to the direct electricity requirements in aircraft manufacturing and indirect electricity requirements in the extraction and refinement of copper and aluminum [20].

*3.3.2. $NO_X$ contributors.* Life-cycle $NO_X$ emissions are often dominated by tailpipe components, however, autos and electric rail modes show non-negligible contributions from other components. Non-operational $NO_X$ emissions are due to several common components from the supply chains of all the modes: direct electricity use, indirect electricity use for material production and processes, and truck and rail transportation. With onroad modes, electricity requirements for vehicle manufacturing and maintenance as well as truck and rail material transport are large contributors [20]. The transport of materials for asphalt surfaces is the primary culprit in roadway and parking construction [21]. Fuel refinery electricity and diesel equipment use in oil extraction add to the component's contribution to total emissions [20]. For rail, the dependence on concrete in infrastructure (resulting in large electricity requirements for cement manufacturing and diesel equipment use in placement) impacts the contribution from construction and maintenance increasing total $NO_X$ emissions by 2.4–12 times for the electric modes and 1.1 times for commuter rail. Aircraft manufacturing, infrastructure operation, and fuel production produce emissions from aircraft that are 1.2 times larger than operational emissions. The direct electricity requirements and truck and rail transport are the key components in aircraft manufacturing.

*3.3.3. CO contributors.* While automobile CO emissions are dominated by the vehicle operation phase, this is not the case for bus, rail, and air modes. Automobile CO emissions are approximately 110 and 40 times larger per PKT than rail and aircraft, respectively, due to a roughly equivalent per vehicle-kilometers-traveled (VKT) emission factor but vastly different occupancy rates. The largest non-operational component is vehicle manufacturing which accounts for about 3% and 28% of total automobile and bus emissions due mainly to truck transport of materials and parts. The production of cement for concrete in stations and truck transport of supplies for insurance operations are the underlying non-operational causes for rail CO emissions. Large concrete requirements result in large CO emissions during cement production for station construction and maintenance [20]. Rail infrastructure emissions (140–260 mg/PKT) are 42–76% of life-cycle emissions (270–430 mg/PKT). Truck transport in aircraft manufacturing, airport ground support equipment (GSE) operation, and jet fuel production produce life-cycle emissions that are 2.6–8.5 times larger than operation (30–180 mg/PKT) [24, 25]. The use of diesel trucks to move parts and materials needed for aircraft manufacturing contributes strongly to the component (20–90 mg/PKT) [20]. The emissions from airport operation are dominated by GSE operations. Particularly, the use of gasoline baggage tractors contributes to roughly half of all GSE emissions [25, 29].

## 4. Sensitivity to passenger occupancy

While the per-VKT performance of any mode can potentially be improved through technological advancements, the per-PKT performance, which captures the energy and emissions intensity of moving passengers, is the result of occupancy rates. An evaluation of these occupancy rates with realistic low and high ridership illustrates both the potential environmental performance of the mode as well as the passenger conditions when modes are equivalent.

Figure 3 highlights these ranges showing average occupancy life-cycle performance and the ranges of performance from low and high ridership (low ridership captures the largest energy consumption and emissions per PKT, at the worst performing times, while high ridership captures the mode's best performance). Auto low occupancy is specified as one passenger and the high as the number of seats. Bus low occupancy is specified as five passengers and the high as 60 passengers (including standing passengers). Rail low occupancy is specified as 25% of the number of seats and the high as 110% of seats (to capture standing passengers). Aircraft low occupancy is 50% and the high is 100% of the number of seats. The occupancy ranges are detailed in SI table S5 (available at stacks.iop.org/ERL/4/024008). Discussion of the environmental performance of transit modes often focuses on the ranking of vehicles assuming average occupancy. This approach does not acknowledge that there are many conditions under which modes can perform equally. For example, an SUV (which is one of the worst energy performers) with 2 passengers (giving 3.5 MJ/PKT) is equivalent to a bus with 8 passengers. Similarly, CA HRT with 120 passengers (27% occupancy giving 1.8 MJ/PKT) is equivalent to a midsize aircraft with 105 passengers (75% occupancy). Similarly, commuter rail (with one of the highest average per-PKT

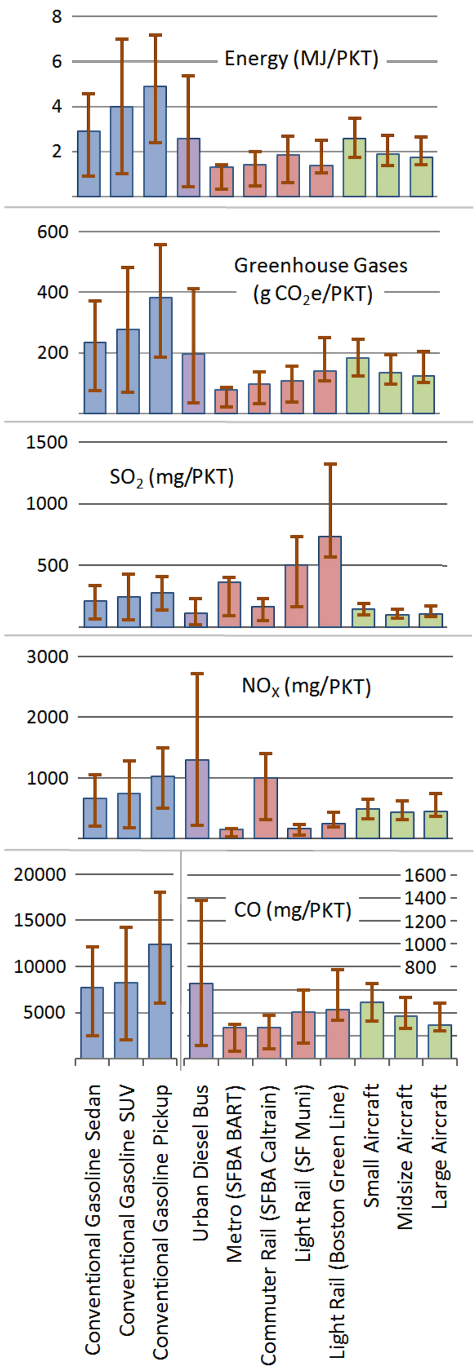


**Figure 3.** Occupancy sensitivity (Average occupancy and life-cycle performance is shown as the blue (autos), purple (bus), red (trains), and green (aircraft) bars. The maroon-colored line captures the range in per-PKT energy consumption and emissions at low and high occupancy).

$NO_X$ emission rates) at 34% occupancy (147 passengers) is equivalent to a bus with 13 passengers or a sedan with one passenger. Focusing on occupancy improvements does not acknowledge the sensitivity of performance to technological changes. For example, holding occupancy at the average, electric rail modes would have to decrease $SO_2$ per-PKT emissions between 24 and 85% to compete with onroad modes, an effort that would have to focus on electricity fuel inputs and scrubbers at power plants.

## 5. Appropriate emission reduction targets

The dominant contributions to energy consumption and GHG emissions for onroad and air modes are from operational components. This suggests that technological advancements to improve fuel economy and switches to lower fossil carbon fuels are the most effective for improving environmental performance. Rail's energy consumption and GHG emissions are more strongly influenced by non-operational components than onroad and air. While energy efficiency improvements are still warranted coupled with lower fossil carbon fuels in electricity generation, reductions in station construction energy use and infrastructure operation could have notable effects. Particularly, the reduction in concrete use or switching to lower energy input and GHG-intensity materials would improve infrastructure construction performance while reduced electricity consumption and cleaner fuels for electricity generation would improve infrastructure operation. Utilizing higher percentages of electricity from hydro and other renewable sources for rail operations could result in significant GHG reductions over fossil-based inputs such as coal.

The life-cycle non-operational components are sometimes responsible for the majority of CAP emissions so reduction goals should consider non-operational processes. $SO_2$ emissions for all modes are heavily influenced by direct or indirect electricity use. Similarly, significant $NO_X$ emission reductions can be achieved through cleaner electricity generation but also the reduction of diesel equipment emissions in transport and material extraction operations. The reductions could be achieved by decreased or cleaner electricity consumption, using equipment with cleaner fuel inputs, or through the implementation of improved emissions controls. While automobile CO emissions are mainly from active operation (with a large portion attributed to the cold start phase), rail emission reductions are best achieved by reducing the use of concrete in stations. A switch away from diesel or gasoline equipment or stronger emission controls can have strong implications for aircraft total CO emissions in truck transport and GSE operations.

This study focuses on conventional gasoline automobiles and it is important to consider the effects of biofuels and other non-conventional energy inputs on life-cycle results. LCAs of biofuels are starting to be developed and will provide the environmental assessments necessary for adjusting primarily the 'fuel production' component of this LCA. Inputs such as electricity for plugin hybrid electric vehicles could also significantly change several components in this study. Batteries in vehicle manufacturing, differing operational characteristics, and electricity production (especially wind and solar) are just some of the components that would affect the results presented here. This study creates a framework for comprehensive environmental inventorying of several modes and future assessment of non-conventional fuels and vehicles can follow this methodology in creating technology-specific results.

Future work should also focus on environmental effects not quantified herein, such as the use of water [30], generation of waste water, and toxic emissions [31]. Detailed assessments of the end-of-life fate of vehicles [32], motor oil [33] and infrastructure [34] should also be factored into decisions.

Through the use of life-cycle environmental assessments, energy and emission reduction decision-making can benefit from the identified interdependencies among processes, services, and products. The use of comprehensive strategies that acknowledge these connections are likely to have a greater impact than strategies that target individual components.

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ROUTING

Independent Policy Report

# Below-Market Housing Mandates as Takings: Measuring their Impact

**Tom Means, Edward Stringham, and Edward Lopez**

November 2007

## *Executive Summary*

Housing affordability has become a major issue in recent years. To address the problem, many cities have adopted a policy known as below-market housing mandates or inclusionary zoning. As commonly practiced in California, below-market housing mandates require developers to sell 10–20 percent of new homes at prices affordable to low-income households.

Many developers, however, argue that the program is in violation of the takings clause of the U.S. Constitution because it forces developers to use some of their property to advance a public goal. Nevertheless, in *Home Builders Association of Northern California v. City of Napa* (2001), the court ruled against the regulatory takings argument, saying that below-market housing mandates are legal because (1) they offer compensating benefits to developers and (2) they necessarily increase the supply of affordable housing.

This study investigates these claims in the following way: Section 2 discusses the history of regulatory takings and discusses why below-market housing mandates may be considered a taking. Section 3 investigates how much below-market housing mandates cost developers. Section 4 investigates econometrically whether below-market housing mandates actually make housing more affordable.

Our research indicates that the decision by the California Courts of Appeal is on shaky ground. Below-market housing mandates require developers to forego substantial amounts of revenue and they provide little offsetting benefit. A mandate in Marin, California, for example, would require developers to forfeit roughly 40 percent of revenue from a project, and builders are offered almost nothing in return.

We can see how below-market housing mandates affect housing markets by using econometrics to analyze data of price and quantity for California cities in 1990 and 2000. Our regressions show that cities that impose a below-market housing mandate actually end up with 10 percent fewer homes and 20 percent higher prices.

For developers, inclusionary zoning has an effect similar to a regulatory taking. For society in general, affordable housing mandates decrease the supply of new housing and increase prices, which exacerbates the affordability problem.

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# Below-Market Housing Mandates as Takings

## *Measuring their Impact*

*Tom Means, Edward Stringham, and Edward Lopez*

### 1. Introduction

High housing prices in recent years are making it increasingly difficult for many to purchase a home. Prices have been rising all over the United States, especially in cities on the East and West Coasts. In San Francisco, for example, the median home sells for $846,500 (Said, 2007, p.c1), which requires yearly mortgage payments of roughly $63,000 (plus yearly property taxes of $8,500).[1] Not only is the median home unaffordable to most, but there is a dearth of affordable homes on the low end, too. In San Francisco, a household making the median income of $86,100 can afford (using traditional lending guidelines) only 6.7 percent of existing homes (National Association of Homebuilders/Wells Fargo, 2007). Households making less are all but precluded from the possibility of home ownership (Riches, 2004).

As a proposed solution, many cities are adopting a policy often referred to as below-market housing mandates, affordable housing mandates, or inclusionary zoning (California Coalition for Rural Housing and Non-profit Housing Association of Northern California, 2003). The specifics of the policy vary by city, but inclusionary zoning as commonly practiced in California mandates that developers sell 10–20 percent of new homes at prices affordable to low-income households. Below-market units typically have been interspersed among market-rate units, have a similar size and appearance as market-rate units, and retain their below-market status for a period of fifty-five years.[2] The program is touted as a way to make housing more affordable, and as a way to provide housing for all income levels, not just the rich. In contrast to exclusionary zoning, a practice that uses housing laws to keep out the poor, inclusionary zoning is advocated as a way to help the poor. Because of its expressed good intentions, the program has gained tremendous popularity. First introduced in Palo Alto, California, in 1973, the program has increased in popularity in the past decade and is now in place in one-third of the cities in California (Non-Profit Housing Association of Northern California, 2007). And it is spreading nationwide, having been already adopted in parts of Maryland, New Jersey, and Virginia (Calavita, Grimes, and Mallach, 1997).

But the program is not without controversy.[3] In *Home Builders Association of Northern California v. City of Napa* (2001), the Home Builders Association maintained that by requiring developers to sell a percentage of their development for less than market price, the "ordinance violated the takings clauses of the Federal and State Constitutions." A ruling by the Court of Appeals in California stated that affordable housing mandates are legal and not a taking because (1) they benefit developers, and (2) they necessarily increase the supply of affordable housing. This report investigates these claims by examining the costs of the programs and reviewing econometrically how they affect the price and quantity of housing.

Our report is organized as follows: Section 2 discusses the history of regulatory takings decisions by the courts and relates them to affordable housing mandates. It provides a brief overview of regulatory takings decisions and discusses the arguments about why affordable housing mandates may or may not be considered a taking. When government allows certain buyers to purchase at below-market prices, it is making sellers sell their property at price-controlled prices. If sellers are not compensated for being forced to sell their property at a below-market price, that may be considered a taking.

Section 3 investigates how much affordable housing mandates cost developers. By calculating the price-controlled level and comparing it to the market price, we can observe the costs to developers each time they sell a price-controlled home. After estimating how much the program costs developers, we discuss to what extent they are being compensated. We find that the alleged benefits to developers pale in comparison to the costs.

Section 4 investigates econometrically whether below-market housing mandates actually make housing more affordable. Using panel data for California cities, we investigate how below-market housing mandates affect the price and quantity of housing. *We find that cities that adopt below-market housing mandates actually drive housing prices up by 20 percent and end up with 10 percent fewer homes.* These statistically significant findings thus bring into question the idea that mandating affordable housing necessarily increases the amount of affordable housing.

Section 5 concludes by discussing why, contrary to *Home Builders Association of Northern California v. City of Napa* (2001), below-market housing mandates should be considered a taking.

## 2. Below-market Housing Mandates and Takings

What are "takings," and should affordable housing mandates be considered a taking? The most familiar form of taking is when the government acquires title to real property for public use, such as common carriage rights of way (roads, rail, or power lines). Precedent for these types of takings is evident in early U.S. jurisprudence, which institutionalized the principle that the government's chief function is to protect private property.[4] As such, the government's takings power was limited in several key respects. Most important, the nineteenth-century Supreme Court prohibited takings that transferred property from one private owner to another and upheld the fundamental fairness doctrine that no individual property owner should bear too much of the burden in supplying public uses.

But government's takings power has expanded over time. Takings restrictions were gradually eroded beginning in the Progressive Era and accelerating during the New Deal, as the Supreme Court increasingly deferred to legislative bodies and an ever-expanding notion of public use. Starting in the latter half of the twentieth century, the stage was set to approve takings for "public uses" such as urban renewal (*Berman v. Parker*, 1954), competition in real estate (*Hawaii Housing v. Midkiff*, 1984), expansion of the tax base (*Kelo v. New London*, 2005), and other types of "economic development takings" (Somin, 2004). By the final decade of the twentieth century, one prominent legal scholar described the public use clause as being of "nearly complete insignificance" (Rubenfeld, 1993, p.1078).

Regulatory takings differ in that they are generally not subject to just compensation, because they rest on the government's police power, not the power of eminent domain. Regulatory takings differ also in that the owner retains title to the property but suffers attenuated rights. For example, a government might rezone an area for environmental conservation and thereby prevent a landowner from developing his property. But does an owner still own his property if he is deprived of using it according to his original intent? These were the essential characteristics of the regulation challenged in *Lucas v. South Carolina Coastal Council* (1992).[5] In that case, David Lucas owned two plots of land that he bought for nearly $1 million and intended to develop. But the South Carolina Coastal Council later rezoned his property, stating that it would be used for conservation. The Court sided with Lucas, saying that if he was deprived of economically valuable use, he must be compensated. Under *Lucas*, federal law requires compensation if the regulation diminishes the entire value of the property, such that an effective taking exists despite no physical removal.

This so-called "total takings" test is one of several doctrines that could be used to judge regulatory takings. For example, the diminution of value test could support compensation to the extent of the harm done to the property owner. This was the Court's tendency in the 1922 case *Pennsylvania Coal v. Mahon*, which found that a regulatory act can constitute a taking depending on the extent to which the value of a property is lowered.[6] So the *Lucas* Court was not up to something new. As a matter of fact, the concept of regulatory takings was discussed by key figures in the American founding era and became an important topic in nineteenth-century legal scholarship as well.[7]

Following in this tradition, the *Lucas* Court addressed several sticking points with regulatory takings law. For example, the majority opinion cited Justice Holmes as stating the maxim that when regulation goes too far in diminishing the owner's property rights, it becomes a taking. However, as the majority opinion pointed out, the Court does not have a well-developed standard for determining when a regulation goes too far to become a taking. Finally, and most important for our purposes, the *Lucas* Court also stressed that the law is necessary to prevent policymakers from using the expediency of police power to avoid the just compensation required under eminent domain. The *Lucas* Court examined regulators' incentives and voiced its discomfort with the "heightened risk that private property is being pressed into some form of public service under the guise of mitigating serious public harm."

Because they rezone land, requiring owners to provide a public service of making low-income housing, below-market housing mandates seem like they fit into the *Lucas* Court's description of what could be considered a taking. This specific issue, however, is still being debated in the courts. In 1999, the Home Builders Association of Northern California brought a case against the City of Napa for mandating that 10 percent of new units be sold at below-market rates. The Home Builders Association argued that the affordable housing mandate violated the Fifth Amendment's takings clause stating that "private property [shall not] be taken for public use without just compensation." The trial court dismissed the complaint, and in 2001, the Court of Appeals decided against the Home Builders Association, arguing that "[a]lthough the ordinance imposed significant burdens on developers, it also provided significant benefits for those who complied."[8] In addition, the California court argued that because making housing more affordable is a legitimate state interest, then below-market housing mandates are legitimate, because they advance that goal. Judge Scott Snowden (who was affirmed by Judges J. Stevens and J. Simons) wrote, "Second, it is beyond question that City's inclusionary zoning ordinance will 'substantially advance' the important governmental interest of providing affordable housing for low and moderate-income families. By requiring developers in City to create a modest amount of affordable housing (or to comply with one of the alternatives) the ordinance will necessarily increase the supply of affordable housing."[9] The Home Builders Association's subsequent attempts to have the case reheard or reviewed by the Supreme Court were denied.

So the Court's argument rests on two propositions that it considers beyond question: (1) affordable housing mandates provide significant benefits to builders that offset the costs, and (2) affordable housing mandates necessarily increase the supply of affordable housing. Both of these are empirical arguments that can be tested against real-world data. We investigate these propositions in the following two sections.

## 3. Estimating the Costs of Below-market Housing Mandates

If one wants to state that "[A]lthough the ordinance imposed significant burdens on developers, it also provided significant benefits for those who complied," one needs to investigate the costs of below-market housing mandates in these programs. Yet when this statement was issued by the Court in 2001, there had been no study of the costs.[10] The first work to estimate these costs was done by Powell and Stringham (2004a). Let us here provide some sample calculations and then present some data for costs in various California cities. Once we present the costs, we can consider whether the programs have significant, offsetting benefits for developers.

First let us consider a real example from Marin County's drafted Countywide Plan.[11] According to the plan, affordable housing mandates would be designated for certain areas of the county (with privately owned property). In these areas, anyone wishing to develop their property would have to sell or lease 50–60 percent of their property at below-market rates.[12]

The plan requires the below-market-rate homes to be affordable to households earning 60–80 percent of the median income, which means price-controlled units must be sold for approximately $180,000–$240,000.[13] How much does such an affordable housing mandate cost developers? New homes are typically sold for more than the median price of housing, but for simplicity let us assume that new homes would have been sold at the median price in Marin, which is $838,750. For each unit sold at $180,002, the revenue is $658,748 less due to the price control. Consider the following sample calculations for a ten-unit project in Marin that show how much revenue a developer could get with and without price controls.

### *Sample calculations for a ten-unit, for sale development in Marin County*

Scenario 1:
Development without price controls
*Revenue from a ten-unit project without price controls*
[(ten market-rate units) x ($838,750 per unit)] = $8,387,500

Scenario 2:
Development with below-market mandate
*Revenue from a ten-unit project, with 50 percent of homes under price controls set for 60 percent of median-income households*
[(five market-rate units) x ($838,750 per unit)] + [(five price-controlled units) x ($180,002 per unit)]= $5,093,760

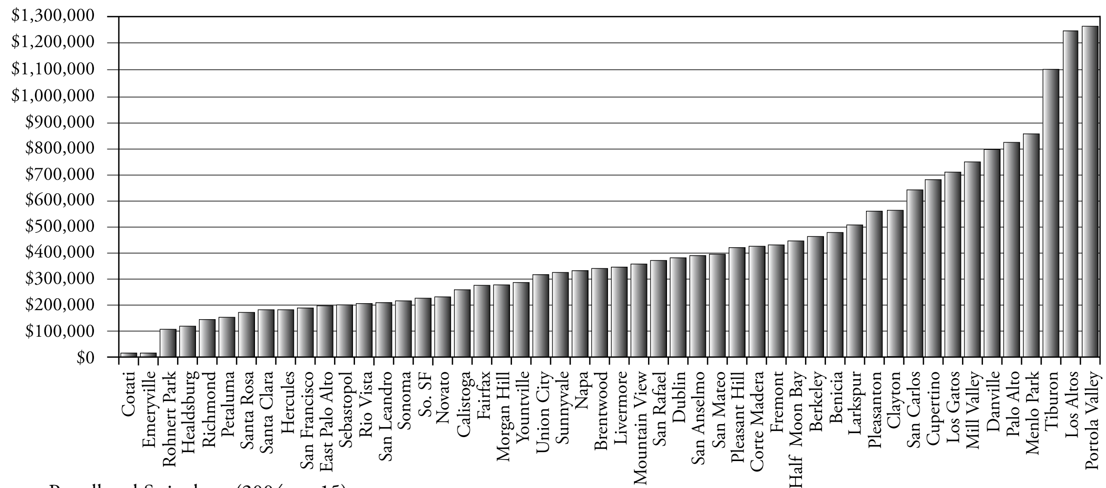
As these calculations show, the below-market housing mandate decreases the revenue from a ten-unit project by $3,293,740, which is roughly 40 percent of the value of a project. This is just one example, and there are many more.

Powell and Stringham (2004a and 2004b) estimate the costs of below-market housing mandates in the San Francisco Bay Area, Los Angeles, and Orange counties. By estimating how much units must be sold for at below-market rates and comparing this to how much homes could be sold for without price controls, one can estimate how much money below-market housing mandates make developers forgo. Even using conservative estimates (to not overestimate costs), these policies cost developers a substantial amount. Figure 1 shows that in the median San Francisco Bay Area city with a below-market housing mandate, each price-controlled unit must be sold for more than $300,000 below the market price. In cities with high housing prices and restrictive price controls, such as Los Altos and Portola Valley, developers must sell below-market-rate homes for more than $1 million below the market price.

One can estimate the costs imposed by these programs on developers by looking at the cost per unit times the number of units built. This measure is not what economists call deadweight costs (which attempts to measure the lost gains from trade from what is not being built), but just a measure of the lost revenue that developers incur for the units actually built. In many cities, no units have been built as a result of the program, but nevertheless, the costs (in current prices) are quite high. The results for the San Francisco Bay Area are displayed in figure 2. In five cities—Mill Valley, Petaluma, Palo Alto, San Rafael, and Sunnyvale—the amount of the "giveaways" in current prices totals over $1 billion.

The next important question is whether developers are getting anything in return. If Mill Valley, Petaluma, Palo Alto, San Rafael, and Sunnyvale were to issue checks to develop-

Figure 1
Average Lost Revenue Associated with Selling Each Below-market-rate Unit in San Francisco Bay Area Cities



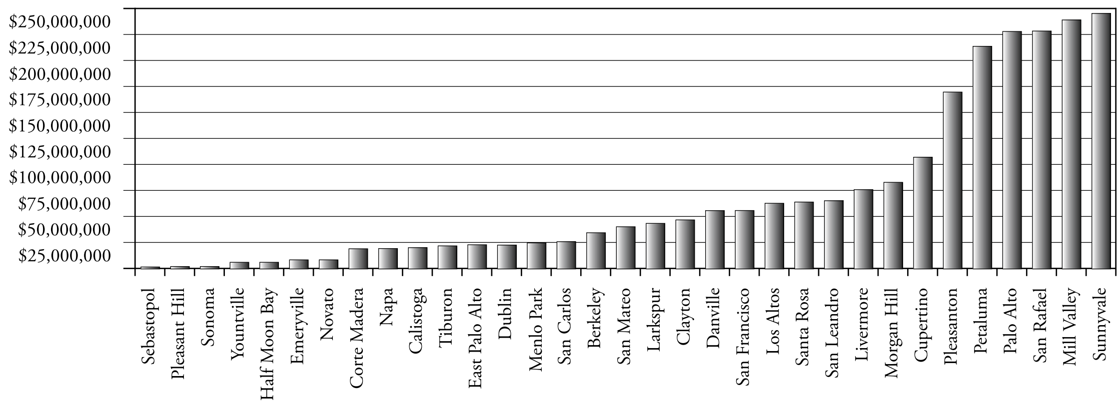

*Source:* Powell and Stringham (2004a, p.15)

ers totaling $1 billion, one could say that even though there was a taking, there was also a type of compensation. But the interesting aspect about affordable housing mandates as practiced in California and most other places is that government offers no monetary compensation at all. In fact, this is one of the reasons why advocates of the program and governments have been adopting it. In the words of one prominent advocate, Andrew Dieterich (1996, p. 41), "a vast inclusionary program need not spend a public dime." In contrast to government-built housing projects, which require tax revenue to construct and manage, affordable-housing mandates impose those costs onto private citizens, namely housing developers. Here we have private parties losing billions of dollars in revenue and receiving no monetary compensation in return.

Monetary compensation for developers is not present, but are affordable housing mandates accompanied by nonmonetary benefits? The Court in *Home Builders Association v. Napa* (2001) stated that "[D]evelopments that include affordable housing are eligible for expedited processing, fee deferrals, loans or grants, and density bonuses."[14] According to California Government Code section 65915, government must provide a density bonus of at least 25 percent to developers who make 20 percent of a project affordable to low-income households. The value of these offsetting benefits will vary based on the specifics, but for full compensation to take place, these benefits would have to be more than $300,000 per home in the median Bay Area city with inclusionary zoning.

One could determine in two ways that the offsetting benefits were worth more than the costs.[15] The first way would be if one observed the building industry actively lobbying for these programs. But in California and most other areas, the building industry is usually the most vocal opponent of these programs. In *Home Builders Association of Northern California v. City of Napa* the court provided no explanation of why the Home Builders Association would be suing to stop a program if it really did provide "significant benefits for those who complied." If the programs really did benefit developers,

Figure 2
Average Lost Revenue Per Unit Times the Number of Units Sold in
Below-market Programs in San Francisco Bay Area Cities




*Source:* Powell and Stringham (2004a, p.15)

there would be no reason why developers would oppose them.

Why don't builders want to sell units for hundreds of thousands less than market price for each unit sold? Or why don't California builders want to forgo billions in revenue? All of the builders with whom we have spoken have stated that the offsetting "benefits" are no benefits at all. For example, a city might grant a density bonus, but the density bonus might be completely unusable, because density restrictions are just one of a set of restrictions on how many units will fit on the property. Other constraints such as setbacks, minimum requirements for public and private open space, floor area ratios, and even tree protections make it extremely complicated to get more units on the property. Conventional wisdom suggests that building at 100 percent of allowable density will maximize profits, but in reality developers tend to build out at less than full density. The City of Mountain View recently passed a policy requiring developers to provide an explanation for projects that failed to meet 80 percent of the allowable density.[16] Prior projects had averaged around 65 percent of allowable density. So giving builders the opportunity to build at 125 percent of allowable density is often worth nothing, when so many other binding regulations exist.

The second and even simpler way to determine whether the affordable housing mandates provide significant benefits to compensate developers for their costs would be to make the inclusionary zoning programs voluntary. Developers could then weigh the benefits and costs of participating, and if the benefits exceeded the costs, the developers could voluntarily comply. A few cities in California tried to adopt voluntary ordinances, and perhaps unsurprisingly, they did not attract developers. One advocate of affordable housing mandates argues that the problem with voluntary programs is "that most of them, because of their voluntary nature, produce very few units" (Tetreault, 2000, p.20).

From these simple observations, we can infer that the significant "benefits" of these programs are not as significant as the costs. In this sense, the program has the character of a regulatory taking. In addition to observing whether builders would support or voluntarily participate in these programs, we can also analyze data to observe how these programs affect the quantity of housing. If the Court in *Home Builders Association v. Napa* is correct that the benefits are significant, then we would predict that imposing an affordable housing mandate would not affect (or it would encourage) housing production in a jurisdiction. If, on the other hand, the program is not compensating for what it takes, we would predict that cities with the program will see less development than in otherwise similar cities without the program. Here the program is a taking that will hinder new development.

## 4. Testing How Below-market Housing Mandates Affect the Price and Quantity of Housing

The court in *Home Builders Association v. Napa* puts forth an important proposition, which we can examine statistically. The court states: "By requiring developers in City to create a modest amount of affordable housing (or to comply with one of the alternatives) the ordinance will *necessarily increase* the supply of affordable housing" (emphasis added). Although the court suggests that it is an a priori fact that price controls will increase the supply of affordable housing, the issue may be a bit more complicated than these appellate judges maintain. Before getting to the econometrics, let us consider some simple economic theory and simple statistics about the California experience. First, if a price control is so restrictive, developers cannot make any profits and so the price control can easily drive out all development from an area. Cities such as Watsonville adopted overly restrictive price controls, and they all but prevented development until they scaled back the requirements (Powell and Stringham, 2005). Over the course of thirty years in the entire San Francisco Bay Area, below-market housing mandates have resulted in the production of only 6,836 affordable units, an average of 228 per year (Powell and Stringham, 2004a, p. 5). Controlling for the length of time each program has been in effect, the average jurisdiction has produced only 14.7 units for each year since adopting a below-market housing mandate. Since the programs have been implemented, dozens of cities have produced a total of zero units (Powell and Stringham, 2004a, pp. 4–5). So unless one defines zero as an increase, it might be more accurate to restate "necessarily increase" as "might increase."

Economic theory predicts that price controls on housing lead to a decrease in quantity produced. Because developers must sell a percentage of units at price-controlled rates in order to get permission to build market-rate units, this policy also will affect the supply of market-rate units. Powell and Stringham (2005) discuss how the policy may be analyzed as a tax on new housing. If below-market-rate housing mandates act as a tax on housing, they will reduce quantity and increase housing price. This is the exact opposite of what advocates of below-market-rate housing mandates say they prefer. So we have two competing hypotheses, that of economic theory, and that of the court in *Home Builders Association v. Napa*. Luckily, we can test these two hypotheses by examining data for housing production and housing prices in California.

Our approach is to use panel data, which has a significant advantage over simple cross-sectional or time-series data. Suppose a city adopts the policy, there is an unrelated statewide decline in demand, and housing output falls by 10 percent. A time-series approach would still have to control for other economic factors that might have changed and reduced housing output. One would still need to compare the reduction in output from a city that adopted the policy to a nearby similar city that did not. A cross-sectional approach can control overall economic factors at a point in time but will not control for unobserved city differences. Our approach is to set up a two-period panel data set to control for unobserved city differences and to control for changes over time. The tests, which we explain in detail below, will enable us to see how adopting a below-market-rate housing mandate will affect variables such as output and prices.

### *4.1. Description of the Data*

The first set of data we utilize consists of the 1990 and 2000 census data for California cities. The 2000 census data are restricted to cities with a population greater than ten thousand, while 1990 census data are not. A decrease in population for some cities during the decade resulted in a loss of fifteen cities from the sample. We do not include the 1980 census, because there were few policies in effect during this decade (Palo Alto passed the first policy in 1972). Focusing on this decade also highlights some economic issues. From 1987 to 1989, housing prices grew very rapidly. Prices for the first half of 1989 grew around 25 percent, only to fall by this amount for the second half of the year, and continue to slide as the California economy declined. For some areas, prices did not recover to their original level until halfway through the 1990 decade. The California economy grew faster in the second half of the decade due to the dot-com boom in the technology sector. Data from the RAND California Statistics Web site provided average home sale prices for each city for the 1990 and 2000 period. The RAND data do not report 1990 home sale prices for some cities, resulting in a loss of more observations. Summary statistics are provided in table 1.

Data on the policy adoption dates came from the California Coalition for Rural Housing and Non-profit Housing Association of Northern California. Table 2 describes the summary statistics of the policy variables that we constructed. IZyr is a dummy variable defined to equal one if the city passed a below-market-rate housing ordinance that year or in prior years. As noted above, differences in population cutoff points and missing 1990 housing prices reduced the sample of cities that passed (or did not pass) an ordinance. Starting in 1985, our sample contains fifteen California cities that had passed an ordinance. The number increased to fifty-nine cities by the end of 1999. The last column reports the difference between decades. In other words, iz95delta reports the number of cities that passed an ordinance between 1985 and 1995. The difference variables are fairly constant and capture a large number of cities that passed ordinances during the decade. Focusing on the 1990–2000 decade should allow us enough observations to capture the impact of the policy.

### *4.2. Empirical Tests*

Jeffrey Wooldridge (2006) provides an excellent discussion of how to test the impact of a policy using two-period panel data. Our approach is to specify a model with unobserved city effects that are assumed constant over the decade (1990–2000) and estimate a first-difference model to eliminate the fixed effect. We also specify a semilog model so that the first difference yields the log of the ratio of the dependent variables over the decade. Estimating the models in logs also simplifies the interpretation of the policy variable coefficient as an approximate percentage change rather than an absolute difference in averages. For the policy variable, we define IZyr as a dummy variable equal to one if the policy was in effect during the current and previous years. To see the importance of the first-difference approach, consider a model specified for each decade.

***Level Model:***

$$\ln Y_{i,t} = \beta_0 + d_0 YR2000_{i,t} + d_1 IZyr_{i,t} + \beta_1 X_{i,t} + a_i + v_{i,t}$$

(Equation 1)

i = city

t = 1990, 2000

The dependent variable is either housing output or housing prices, YR2000 is a dummy variable allowing the intercept to change over the decade, IZyr is the policy dummy variable, and the X are control variables. The error term contains two terms: the *unobserved* fixed city component ($a_i$) considered fixed for the decade (e.g., location, weather, political tastes); and the usual error component ($v_{it}$). If the unobserved fixed effect is uncorrelated with the exogenous variables, one can estimate the model using ordinary-least-squares for each decade. The coefficient for IZyr measures the impact of the policy for each decade.[17] Unfortunately, estimating the level model may not capture the differences between cities that passed an ordinance and the ones that did not. In other words, suppose cities with higher housing prices are more likely to adopt the policy. The dummy variable may capture the impact of the policy along with the fact that these cities already have higher prices.

The above issues can be addressed by differencing the level models to eliminate the fixed city effect, which yields the first-difference model.[18]

***First-Difference Model***

$$\ln Y_{i,2000} - \ln Y_{i,1990} = d_0 + d_1 IZyr_{i,2000} - d_1 IZyr_{i,1990} + \beta_1 X_{i,2000} - \beta_1 X_{i,1990} + v_{i,2000} - v_{i,1990}$$

(Equation 2)

i = city

which can be rewritten as:

$$\ln(Y_{i,2000}/Y_{i,1990}) = d_0 + d_1 \Delta IZyr_{i,t} + \beta_1 \Delta X_{i,t} + \Delta v_{i,t}$$

(Equation 3)

i = city

t = 2000

Eliminating the unobserved fixed city effect, which we show below in the last two columns of tables 3 and 4, has an important effect on estimating the impact of the policy variable. Differencing the panel data also yields a dummy variable that represents the change in policy participation over the decade (an example of this is the iz95delta appearing in tables 2 through 6). When policy participation takes place in both periods (1990 and 2000), the interpretation of the differenced dummy is slightly different from the usual policy treatment approach. The differenced dummy variable predicts the average change in the dependent variable due to an increase (or decrease) in participation.

To see the advantage of the first-difference approach, we first estimated (without control variables, which we will add in tables 5 and 6) the un-differenced equations of the log of aver-

**Table 1 Summary Statistics**

| Variable | Observations | Mean | Standard Deviation | Minimum | Maximum |
|---|---|---|---|---|---|
| Population 2000 | *N*=446 | 65,466 | (197,087) | 10,007 | 3,694,834 |
| Population 1990 | *N*=431 | 58,468 | (187,014) | 1,520 | 3,485,398 |
| Households 2000 | *N*=446 | 22,251 | (68,673) | 1,927 | 1,276,609 |
| Households 1990 | *N*=431 | 20,512 | (66,074) | 522 | 1,219,770 |
| Housing Units 2000 | *N*=446 | 23,278 | (71,843) | 2,069 | 1,337,668 |
| Housing Units 1990 | *N*=431 | 21,745 | (70,331) | 597 | 1,299,963 |
| Density 2000 (persons/acre) | *N*=446 | 7.62 | (6.06) | 0.42 | 37.32 |
| Density 1990 (persons/acre) | *N*=431 | 6.87 | (5.88) | 0.08 | 37.01 |
| Median Household Income 2000 | *N*=446 | 52,582 | (21,873) | 16,151 | 193,157 |
| Median Household Income 1990 | *N*=431 | 38,518 | (14,543) | 14,215 | 123,625 |
| Per Capita Income 2000 | *N*=446 | 23,903 | (13,041) | 7,078 | 98,643 |
| Per Capita Income 1990 | *N*=431 | 16,696 | (8,070) | 4,784 | 63,302 |
| Rents/Income 2000 | *N*=446 | 27.60% | (3.1%) | 14.4% | 50.1% |
| Rents/Income 1990 | *N*=431 | 28.9% | (2.7%) | 14.9% | 35.1% |
| Average Home Price 2000 | *N*=360 | 300,594 | (235,436) | 49,151 | 2,253,218 |
| Average Home Price 1990 | *N*=352 | 206,754 | (112,804) | 52,858 | 1,018,106 |

age housing prices and output ($\ln Y_{i,t} = \beta_0 + d_1 IZyr_{i,t}$) over various lagged policy dummies. The first four columns in table 3 report the estimated coefficients ($d_1$) for each lag year for the level models. The left two columns show the coefficient estimates for the five regressions that look at housing prices in 1990 and have iz1985, iz1986, iz1987, iz1988, or iz1989 as the policy variable. The third and fourth columns in table 3 show the coefficient estimates for the five regres-

**Table 2 Summary Statistics – Policy Variables**

| Variable | # of cities with inclusionary zoning (in that year) | Variable | # of cities with inclusionary zoning (in that year) | Variable | Change in # of cities with inclusionary zoning (over 10 years) |
|---|---|---|---|---|---|
| iz1985 | 15 | iz1995 | 50 | iz95delta (which is iz1995-iz1985) | 35 |
| iz1986 | 19 | iz1996 | 52 | iz96delta (which is iz1996-iz1986) | 33 |
| iz1987 | 19 | iz1997 | 54 | iz97delta (which is iz1997-iz1987) | 35 |
| iz1988 | 22 | iz1998 | 54 | iz98delta (which is iz1998-iz1988) | 32 |
| iz1989 | 23 | iz1999 | 59 | iz99delta (which is iz1999-iz1989) | 36 |

**Table 3 Summary of Policy Coefficients from Fifteen Regressions on the Price of Housing by Model and by Lag Year**

**Dependent Variable: ln(Price)**

| **Level models for 1990 data** | | **Level models for 2000 data** | | **First-difference models (2000–1990)** | |
|---|---|---|---|---|---|
| Policy Variable | Coefficient of Policy Variable | Policy variable | Coefficient of Policy Variable | Policy variable | Coefficient of Policy Variable |
| iz1985 | .389 | iz1995 | .627 | iz95delta | .312 |
| iz1986 | .431 | iz1996 | .642 | iz96delta | .298 |
| iz1987 | .431 | iz1997 | .637 | iz97delta | .278 |
| iz1988 | .442 | iz1998 | .637 | iz98delta | .270 |
| iz1989 | .457 | iz1999 | .642 | iz99delta | .265 |

sions that look at housing prices in 2000 and have iz1995, iz1996, iz1997, iz1998, or iz1999 as the policy variable. For example, the 0.389 in the first row indicates that cities with inclusionary zoning in 1985 had 47.6 percent (exp(0.389) - 1) higher than average prices in 1990, and the 0.627 in the first row indicates that cities with inclusionary zoning in 1995 had 87.2 percent higher-than-average prices in 2000. For both decades, the impact increases slightly as the lag period is decreased, though the impact for the 2000 period is much larger than the 1990 period.

**Table 4 Summary of Policy Coefficients from Fifteen Regressions on the Quantity of Housing by Model and by Lag Year**

**Dependent Variable: ln(Housing Units)**

| **Level models for 1990 data** | | **Level models for 2000 data** | | **First-difference models (2000–1990)** | |
|---|---|---|---|---|---|
| Policy Variable | Coefficient of Policy Variable | Policy variable | Coefficient of Policy Variable | Policy variable | Coefficient of Policy Variable |
| iz1985 | .777 | iz1995 | .665 | iz95delta | -.045 |
| iz1986 | .751 | iz1996 | .614 | iz96delta | -.024 |
| iz1987 | .751 | iz1997 | .585 | iz97delta | -.027 |
| iz1988 | .679 | iz1998 | .585 | iz98delta | -.038 |
| iz1989 | .653 | iz1999 | .618 | iz99delta | -.051 |

The estimated coefficients ($d_1$) for 1990 and 2000 range from 0.389 to 0.642 and indicate that cities with inclusionary zoning have 48–90 percent higher housing prices, but this does not take into consideration the possibility that cities that adopted the policy already had higher prices when they did so. To account for this potential problem, the first-difference model estimates how changes in the policy variable (adopting a below-market housing ordinance) alone affect housing prices. The last two columns of table 3 report the first-difference estimates ($\ln(Y_{i,2000}/Y_{i,1990}) = d_0 + d_1 \Delta IZyr_{i,t}$). For example, the 0.312 in the last column of the first row indicates that cities with below-market housing mandates have 36.6 percent higher prices. Each of the estimated coefficients in table 3 are significant at the 1 percent level. The results in the last two columns indicate that below-market housing mandates have increased the price of the average home by 30 to 37 percent.

The results for housing output (the number of units) are even more interesting. These results are presented in table 4. The estimates of $d_1$ for the level models for 1990 and 2000 are positive and statistically significant at the one percent level, which indicates that cities with inclusionary zoning have more housing production, but similar to the housing price regressions do not take into consideration the possibility that cities that adopted the policy already were growing when they adopted the policy. Again, we need to look at the difference in output based on cities adopting the policy. The last two columns in table 4 show how changes in the policy variable (adopting a below-market-rate housing ordinance) alone affect the quantity of housing. Eliminating the unobserved fixed effect by differencing the data switches the sign of the policy variable from positive to negative (though most are statistically insignificant without control variables). This switch in sign of $d_1$ provides strong evidence of the importance of eliminating the unobserved fixed city effect. The negative impact increases in size and statistical significance when control variables are added to the first-difference model.

**Table 5 Regression Results of How Below-market Housing Mandates Affect the Price of Housing: First-difference Model with Control Variables**

**Dependent Variable: ln(average price 2000/1990)**

| **Independent Variable** | **Coefficients and (Standard Errors)** *N*=431 | **Coefficients and (Standard Errors)** *N*=431 |
|---|---|---|
| Constant | 0.001<br>(0.025) | -0.009<br>(0.025) |
| iz95delta | 0.228***<br>(0.038) | |
| iz99delta | | 0.217***<br>(0.037) |
| median income | 0.173***<br>(0.0126) | 0.178***<br>(0.0125) |
| density | -0.007<br>(0.011) | -0.008<br>(0.011) |
| population | -0.0017<br>(0.00661) | -0.00112<br>(0.00662) |
| rent % | -0.002<br>(0.005) | -0.003<br>(0.005) |
| Adj. R-Squared | 0.4332 | 0.4300 |

Tables 3 and 4 indicate the importance of differencing the data and removing the unobserved fixed city effect.[19] The next set of regressions in table 5 report first-difference estimates for housing prices for the five-year and one year lag while adding other control variables that may change over time.[20] The other models (using lag periods iz96delta, iz97delta, and iz98delta) yielded similar results. Adding income, whether median household income or per capita income, increases the size of the estimated policy effect. All policy estimates of $d_1$ are larger than 0.20, suggesting that *cities that impose an affordable housing mandate drive up prices by more than 20 percent*. Dropping the insignificant variables and adjusting for heteroscedasticity had little impact on the policy and income variables.

The final set of results in table 6 reports the estimated effects on housing quantity for the same lag periods as the price estimates. The results are nearly identical for the other lag periods (iz96delta, iz97delta, and iz98delta). Adding control variables increases the policy impact and its statistical significance. Substituting the number of households for the number of units as the dependent variable does not alter the main results. Adjusting for heteroscedasticity did increase the statistical significance levels slightly for the policy variable. The negative policy coefficients (-0.104 and -0.097) suggest that cities that impose an affordable housing mandate reduce housing units by more than 10 percent.

**Table 6 Regression Results of How Below-market Housing Mandates Affect the Quality of Housing: First-difference Model with Control Variables**

**Dependent Variable: ln(units 2000–1990)**

| **Independent Variable** | **Coefficients and (Standard Errors)** *N*=431 | **Coefficients and (Standard Errors)** *N*=431 |
|---|---|---|
| Constant | -0.056** (0.023) | -0.054** (0.023) |
| iz95delta | -0.104** (0.042) | |
| iz99delta | | -0.097** (0.041) |
| median income | 0.0683*** (0.0132) | 0.0660*** (0.0131) |
| density | 0.113* (0.011) | 0.114 (0.011) |
| population | 0.0233* (0.00729) | -0.0230* (0.00729) |
| Adj. R-Squared | 0.2921 | 0.2911 |

Note: *, **,*** denotes significance at the .10, .05, .01 levels, two-tailed test.

## 5. Conclusion

Our research provides answers to two important questions: How much do below-market housing mandates cost developers, and do below-market housing mandates improve housing affordability? After showing that below-market housing mandates cost developers hundreds of thousands of dollars for each unit sold, we discussed how developers do not receive compensation in this amount. Next we investigated how these policies affected the supply of housing. Using panel data and first difference estimates, we found that below-market housing mandates lead to decreased construction and increased prices. Over a ten-year period, cities that imposed a below-market housing mandate on average ended up with 10 percent fewer homes and 20 percent higher prices. These results are highly significant. The assertion by the court in *Home Builders Association v. Napa* that "the ordinance will necessarily increase the supply of affordable housing" is simply untrue.

The justification for the decision that below-market housing mandates are not a taking rests on some extremely questionable economic assumptions. We are not sure about the amount of economics knowledge of Judges Scott Snowden, J. Stevens, and J. Simons. Below-market housing mandates are simply a type of price control, and nearly every economist agrees that price controls on housing lead to a decrease in quantity and quality of housing available (Kearl et al., 1979, p.28). Because these price controls apply to a percentage of new housing, and builders must comply with them if they want to build market-rate housing, price controls also will affect the supply of market-rate housing. Because price controls act as a tax on new housing, we would expect a supply shift leading to less output and higher prices for all remaining units.

New names for price controls, like "inclusionary zoning," make the policy sound innocuous or even beneficial (who can be against a policy of inclusion?), but in reality the program is a mandate that imposes significant costs on a minority of citizens. The costs of below-market housing mandates are borne by developers and other new homebuyers who receive little or no compensation. From this perspective, below-market housing mandates are a taking no different in substance from an outright taking under eminent domain. Below-market housing mandates represent the sort of abuse the *Lucas* Court forewarned, and they should rightly be considered a taking. In terms of economics, below-market housing mandates only differ from an outright taking in degree—there is not a "total taking" but a partial taking and clearly a diminution of value without any compensation. The amount of harm imposed by below-market housing mandates should inform their status under the law.

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*Kelo et al. v. City of New London, Connecticut*, 545 U.S. 469 (2005).

*Lucas v. South Carolina Coastal Council*, 505 U.S. 1003 (1992).

*Poletown Neighborhood Council v. Detroit*, 410 Mich. 616, 304 N.W. 2d 455 (1981).

## Notes

1 Assuming a 30-year fixed-interest-rate mortgage with an interest rate of 6.3 percent.

2 For details about the program, see California Coalition for Rural Housing and Non-Profit Housing Association of Northern California (2003) and Powell and Stringham (2004a).

3 For review of the literature, see Powell and Stringham (2005).

4 "The country that became the United States was unique in world history in that it was founded by individuals in quest of private property. . . . [T]he conviction that the protection of property was the main function of government, and its corollary that a government that did not fulfill this obligation forfeited its mandate, acquired the status of a self-evident truth in the minds of the American colonists." Pipes (1999, p.240).

5 *Lucas v. South Carolina Coastal Council*, 505 U.S. 1003 (1992).

6 *Pennsylvania Coal v. Mahon 260*, U.S. 393 (1922).

7 As 1egal scholar James Ely writes, "In his famous 1792 essay James Madison perceptively warned people against government that '*indirectly* violates their property, in their actual possessions.' Although Madison anticipated the regulatory takings doctrine, the modern doctrine began to take shape in the last decades of the nineteenth century. For example, in a treatise on eminent domain published in 1888, John

Lewis declared that when a person was deprived of the possession, use, or disposition of property 'he is to that extent deprived of his property, and, hence . . . his property may be taken, in the constitutional sense, though his title and possession remain undisturbed.' Likewise, in 1891 Justice David J. Brewer pointed out that regulation of the use of property might destroy its value and constitute the practical equivalent of outright appropriation. While on the Supreme Judicial Court of Massachusetts, Oliver Wendell Holmes also recognized that regulations might amount to a taking of property. 'It would be open to argument at least,' he stated, 'that an owner might be stripped of his rights so far as to amount to a taking without any physical interference with his land.'" (Ely, 2005, p.43, footnotes in original omitted.)

8 *Home Builders Association of Northern California v. City of Napa* (2001), p. 188.

9 *Home Builders Association of Northern California v. City of Napa* (2001), pp. 195–6.

10 The California Coalition for Rural Housing and Non-profit Housing Association of Northern California (2003, p.3) stated, "These debates, though fierce, remain largely theoretical due to the lack of empirical research."

11 Marin County is one of the highest-income and most costly areas in the San Francisco Bay Area.

12 http://www.co.marin.ca.us/EFiles/Docs/CD/PlanUpdate/07_0430_IT_070430091111.pdf (accessed August 19, 2007). To simplify the specifics, developers have the choice of selling 60 percent of homes to low-income households or 50 percent of homes to very-low-income households, which calculates to roughly the same loss of revenue, so for simplicity we will focus on the latter scenario.

13 Median income for a household of four is $91,200, so a household earning 80 percent of median income earns $73,696, and a household earning 60 percent of the median income earns $55,272. The specific affordability price control formula will depend on certain assumptions (for example, the level of the interest rate in the formula), but using some standard assumptions we can create an estimate (assuming homes will be financed with 0 percent down, a 30-year, fixed-rate mortgage, and an interest rate of 7 percent, and assuming that 26 percent of income will pay mortgage payments and 4 percent of income will pay for real estate taxes and other homeowner costs).

This formula gives us how much a household in each income level could afford and the level of the price controls. In Marin County, a home sold to a four-person household earning 80 percent of median income could be sold for no more than $240,003, and a home sold to a four-person household earning 60 percent of the median income could be sold for no more than $180,002.

The price controls may be set at stricter levels, depending on the city ordinance. For example, the City of Tiburon sets price controls for "affordability" much more strictly than the above formula. Its ordinance assumes an interest rate of 9.5 percent and assumes that 25 percent of income can be devoted to a mortgage. According to Tiburon's ordinance, a "moderate," price-controlled home can be sold for no more than $109,800.

14 *Home Builders Association of Northern California v. City of Napa* (2001), p.194.

15 Powell and Stringham (2005) discuss this issue in depth.

16 Policy on Achieving Higher Residential Densities in Multiple-Family Zones, (September 13, 2005).

17 For those readers unfamiliar with semilog models, $d_1$ provides an interpretation of the policy variable as a percentage change. The estimate of $d_1$ is interpreted as the approximate percentage change in Y for cities that pass an ordinance. When the estimate of $d_1$ is large (greater than 10 percent), the more accurate estimate is $\%\Delta Y = \exp(d_1) - 1$.

18 The first difference model is the fixed-effects model when there are two time periods.

19 Controlling for the endogeneity of the policy variable will have little or no impact. The data reveal that cities that passed an ordinance also have higher housing prices on average. It may be that higher-priced cities are more likely to pass an ordinance. Given our results, we have some doubts about whether this will impact our conclusion. First we lagged the policy variable from one to five years and found very little variation in the OLS estimates. A lag of five years (for a potential dependent variable) should reduce or eliminate the potential bias. Second, the first-difference approach reduced the price effect and significantly changed the output effect by controlling for unobserved fixed effects. Finally, there are some limits to finding instrumental variables for a first-difference model. Clearly it would not be appropriate to use any of the 2000 data to control for policies passed in earlier years. One could use the 1990 census data, but even here there are some cities that passed the policy prior to 1990. For these reasons, we believe controlling for endogeneity will not change the basic results.

20 The income and population variables are rescaled in units of ten thousand to simplify the coefficient presentation.

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