BERKELEY IGS Research Brief

Housing Production, Filtering and Displacement: Untangling the Relationships

Miriam Zuk
Karen Chapple

EXECUTIVE SUMMARY:

Research Implies the Importance of Increasing Production of Subsidized and Market-Rate Housing

Debate over the relative importance of subsidized and market-rate housing production in alleviating the current housing crisis continues to preoccupy policymakers, developers, and advocates. This research brief adds to the discussion by providing a nuanced analysis of the relationship between housing production, affordability, and displacement in the San Francisco Bay Area, finding that:

- At the regional level, both market-rate and subsidized housing reduce displacement pressures, but subsidized housing has over double the impact of market-rate units.
- Market-rate production is associated with higher housing cost burden for low-income households, but lower median rents in subsequent decades.
- At the local, block group level in San Francisco, neither market-rate nor subsidized housing production has the protective power they do at the regional scale, likely due to the extreme mismatch between demand and supply.

Although more detailed analysis is needed to clarify the complex relationship between development, affordability, and displacement at the local scale, this research implies the importance of not only increasing production of subsidized and market-rate housing in California's coastal communities, but also investing in the preservation of housing affordability and stabilizing vulnerable communities.

About IGS

The Institute of Governmental Studies is California's oldest public policy research center. As an Organized Research Unit of the University of California, Berkeley, IGS expands the understanding of governmental institutions and the political process through a vigorous program of research, education, public service, and publishing.

Housing Production, Filtering, and Displacement: Untangling the Relationships

Introduction

The ongoing crisis of housing affordability in California has deepened the divide between those who believe it can be resolved by expanding the supply of market-rate housing and those who believe that market-rate construction on its own will not meet the needs of low-income households, for whom more subsidized housing needs to be built or stabilized. These arguments over the role of market-rate versus subsidized housing have plagued strong-market cities, which are engaging in political debates at the ballot box (e.g., the "Mission Moratorium," a ballot measure that would ban luxury units in San Francisco's Mission neighborhood) and in city hall (e.g., housing density bonus programs like New York City's inclusionary housing plan) over the role and impact of housing development.

In the February 2016 report "Perspectives on Helping Low-Income Californians Afford Housing" (hereafter "the LAO Report"), the California Legislative Analyst's Office (LAO) used data we posted on our Urban Displacement Project website (www.urbandisplacement.org) to argue that market-rate development would be the most effective investment to prevent low-income households from being displaced from their neighborhoods.[1]

In this research brief we present a more nuanced view to contribute to this debate. We correct for the omission of subsidized housing production from the LAO Report and find that both market-rate and subsidized housing reduce displacement at the regional level, yet subsidized housing has over double the impact of market-rate units. After evaluating the impact of market-rate and subsidized housing built in the 1990s on displacement occurring in the 2000s, to ensure that we are examining before and after relationships, we find that market-rate development has an insignificant effect on displacement. Finally, when looking at the local, neighborhood scale in San Francisco, neither market-rate nor subsidized housing production has the protective power they do at the regional scale, likely due to the extreme mismatch between demand and supply. These findings provide further support for continuing the push to ease housing pressures by producing more housing at all levels of affordability throughout strong-market regions. These findings also provide support for increasing spending on subsidized housing to ensure both neighborhood stability and income diversity into the future.

. . . we found that both market-rate and subsidized housing development can reduce displacement pressures, but subsidized housing is twice as effective as market-rate development at the regional level.

We begin this research brief by describing why the filtering process, the phenomenon in which older market-rate housing becomes more affordable as new units are added to the market, may fall short of producing affordable housing. We next revisit the question of the impact of market-rate development, looking also at the role of subsidized housing development, in mitigating displacement. After an examination of the impact of housing production on displacement over the short- and long-term, we look at why adding to housing supply in a region might not reduce housing market pressures in all neighborhoods. We conclude by suggesting next steps for research.

Filtering Is Not Enough

Using our data, the LAO report concluded that the most important solution to the housing crisis in California's coastal communities is to build more market-rate housing. The report found that new market-rate construction reduced displacement of low-income households across the region. After outlining the challenges and limited funding for subsidized units, the report argued that filtering, or the phenomenon in which older market-rate housing becomes more affordable as new units are added to the market, was the most effective way to exit the affordable-housing crisis. The report neglects the many challenges of using market-rate housing development as the main mechanism for providing housing for low-income households, in particular the timing and quality of the "filtered" housing stock.[2] The filtering process can take generations, meaning that units may not filter at a rate that meets needs at the market's peak, and the property may deteriorate too much to be habitable. Further, in many strong-market cities, changes in housing preferences have increased the desirability of older, architecturally significant property, essentially disrupting the filtering process.

Although our data is not tailored to answer questions about the speed of filtering, other researchers[3] have found that on average across the United States, rental units become occupied by lower-income households at a rate of approximately 2.2% per year. Yet in strong housing markets such as California and New England the rate is much lower and researchers find that filtering rates have an inverse relationship with housing price inflation; in other words, places that have rapidly rising housing prices have slower filtering rates.[4] Using the estimates of Rosenthal (2014) and an annual appreciation rate

of 3.3% over the last 20 years, the pace at which units filter down to lower-income households for the Bay Area's rental market is estimated at roughly 1.5% per year. Yet, Rosenthal finds that rents decline by only 0.3% per year, indicating that units become occupied by lower-income households at a faster rate than rents are falling, which could result in heightened housing cost burden. Furthermore, if we were to assume that developers are building housing for people at the median income, then it would take approximately 15 years before those units filtered down to people at 80% of the median income and closer to 50 years for households earning 50% of the median income.[5] Again, however, this does not mean that such units are actually affordable to the low-income households occupying them.

We examined the relationship between market-rate housing construction, rents, and housing cost burden (Table 1). Initial results indicate a filtering effect for units produced in the 1990s on median rents in 2013. Yet market-rate development in the 2000s is associated with higher rents, which could be expected as areas with higher rents are more lucrative places for developers to build housing. Furthermore, development in both the 1990s and 2000s is positively associated with housing cost burden for low-income households. Thus, while filtering may eventually help lower rents decades later, these units may still not be affordable to low-income households.

Developing Subsidized Units Is Even More Protective

While numerous critiques of the LAO report have circulated,[6] we believe that the omission of subsidized housing production data from the analysis has the greatest potential to skew results.[7] We have reanalyzed the data on housing production, including that of subsidized housing, and show that the path to reducing displacement is more complex than to simply rely on market-rate development and filtering. Following, we present our analysis that replicates the LAO analysis with the addition of subsidized housing data.

To examine the relationship between market-rate housing construction, subsidized housing construction, and displacement of low-income households, we developed an econometric model that estimates the probability of a low-income Bay Area neighborhood experiencing displacement. We employ the same methodology as the LAO Report, using probit regression analysis to evaluate how various factors affect the likelihood of a census tract experiencing displacement between 2000 and 2013 (see the technical appendix for definitions).

Consistent with the LAO Report, we find that new market-rate units built from 2000 to 2013 significantly predict a reduction in the displacement indicator from 2000 to 2013 (Table 2, Model 1).[8] Higher shares of nonwhite population and higher housing density also produced significant reductions in displacement. Higher shares of housing built before 1950, college-educated population in 2000, and low-income population in 2000 increased the likelihood of the census tract experiencing displacement. These results are generally consistent with previous research: existing residents in neighborhoods with historic housing stock and college-educated populations are at higher risk of displacement.[9] We also find, however, that the production of subsidized units has a protective effect, which appears to be greater than the effect of the market-rate units (Model 2). This includes units built with low-income housing tax credits and other federal and state subsidies.[10] We find the effect of subsidized units in reducing the probability of displacement to be more than double the effect of market-rate units. In other words, for every one subsidized unit, we would need to produce two or more market-rate units to have the same reduction in displacement pressure.[11]

What we find largely supports the argument that building more housing, both market-rate and subsidized, will reduce displacement. However, we find that subsidized housing will have a much greater impact on reducing displacement than market-rate housing. We agree that market-rate development is important for many reasons, including reducing housing pressures at the regional scale and housing large segments of the population. However, our analysis strongly suggests that subsidized housing production is even more important when it comes to reducing displacement of low-income households.

ABOUT THE AUTHORS

Miriam Zuk, Ph.D. is project director of the Urban Displacement Project at UC Berkeley. She specializes in equitable development and environmental justice. Dr. Zuk holds a B.A. in Environmental Sciences from Barnard College, an M.S. in Technology and Policy from MIT, and a Ph.D. in City and Regional Planning from UC Berkeley. Prior to academia, she served as the Deputy Director of Air Quality Research for the Mexican Ministry of Environment.

Karen Chapple, Ph.D., is a Professor of City and Regional Planning at the University of California, Berkeley. She specializes in housing, community and economic development, as well as regional planning. Chapple holds a B.A. in Urban Studies from Columbia University, an M.S.C.R.P from the Pratt Institute, and a Ph.D. from UC Berkeley. Prior to academia, Chapple spent ten years as a practicing planner in economic development, land use, and transportation in New York and San Francisco.

Table 1. The Impact of Development on Median Rent and Housing Cost Burden for Low-Income Households for the SF Bay Area Census Tracts (linear model)

	Median Rent (2009-2013)	Percent of Low Income Households that are Housing Cost Burdened (2009-2013)
% of housing units built pre-1950 in 2000	-202.52***	-0.04***
% of population nonwhite in 2000	47.28	0.08***
% of adult population with college degree in 2000	445.65***	0.03*
Housing density (pop/square mile) in 2000	2.6E-04	-1.6E-07
% of households with income below 80% of county median in 2000	-1185.37***	-0.05**
Number of new market-rate units built between 1990-2000	-0.05**	2.7E-05***
Number of new market-rate units built between 2000-2013	0.07***	2.6E-05***
Proximity to rail transit station (<1/2 mile) in 2000	60.30***	0.01
Intercept	1827.80***	0.56***
n	1569	1568
R^2	0.51	0.06
***<.01 **<.05 *<.10 significance level		

Table 2. The Impact of Market-Rate and Subsidized Developments on Displacement Bay Area Tracts 2000-2013

	Model 1	Model 2
% of housing units built pre-1950 in 2000	0.612***	0.481***
% of population nonwhite in 2000	-0.956***	-0.943***
% of adult population with college degree in 2000	1.775***	1.824***
Housing density (pop/square mile) in 2000	-1.04E-05***	-1.01E-05***
% of households with income below 80% of county median in 2000	2.447***	3.054***
Number of new market-rate units built between 2000-2013	-0.002***	-0.002***
Number of subsidized units built between 2000-2013	--	-0.005***
Intercept	-1.576***	-1.709***
n	1569	1569
Pseudo R^2	0.1456	0.1693
***<.01 **<.05 *<.10 significance level		

Table 3. The Impact of Market-Rate and Subsidized Developments on Displacement Bay Area Tracts 1990-2000 and 2000-2013

	Model 3	Model 4	Model 5
% of housing units built pre-1950 in 2000	0.614***	0.565***	0.446**
% of population nonwhite in 2000	-1.071***	-1.090***	-0.9555***
% of adult population with college degree in 2000	1.689***	1.700***	1.820***
Housing density (pop/square mile) in 2000	-5.95E-06*	-5.09E-06	-9.73E-06**
% of households with income below 80% of county median in 2000	2.251***	2.474***	3.105***
Number of new market-rate units built between 1990-2000	-3.25E-04**	-2.91E-04**	-6.85E-05
Number of subsidized units built between 1990-2000	--	-0.004***	-0.002*
Number of new market-rate units built between 2000-2013	--	--	-0.002***
Number of subsidized units built between 2000-2013	--	--	-0.005***
Intercept	-1.613***	-1.660***	-1.699***
n	1571	1571	1569
Pseudo R^2	0.108	0.118	0.171

***<.01 **<.05 *<.10 significance level

The Effectiveness of Market-Rate Production in Mitigating Displacement Diminishes over Time

The LAO Report used data that we posted to our website for housing production numbers that were built over the same time period as our data on the change in low-income households. Yet, since both housing production and household change are occurring in a 13-year period from 2000 to 2013, it is unclear which came first: conceivably, the change in households occurred before the development, rather than vice versa, however it is also feasible that developers prefer to build in neighborhoods experiencing a decline in low-income households. This creates the potential for errors in the model. To account for this, we correct the potential error in the LAO Report by adding housing production data that precede changes in low-income households, which we use as the proxy for displacement. In other words, instead of looking at the incidence of displacement in the same decade as housing production, we evaluate the impact of market-rate and subsidized housing built in one decade (e.g., 1990s) on what happens to residents in a subsequent decade (e.g., 2000s).

We find that market-rate housing built in the 1990s significantly reduces the incidence of displacement from 2000 to 2013 (Table 3, Model 3), confirming the findings of the LAO Report. Yet, once again, subsidized housing built in the previous decade has more than double the effect of market-rate development in that decade (Model 4). When looking at housing production in both the 1990s and 2000s (Model 5), subsidized housing continues to play a greater role in mitigating displacement in 2010s, while market development in the 1990s becomes insignificant. This suggests that there are factors dictating development in the 1990s that are related to development in the 2000s as well as displacement that are not included in the model, such as housing sales prices or school quality. An alternative interpretation of the disappearance of an effect for market-rate housing built in the 1990s is that market-rate housing in and of itself, or the filtering process, has no effect on displacement. Future research will need to further analyze these relationships as well as other factors that may improve the predictive power of the models.

Regardless of when construction happens relative to displacement—before or concurrently—our analysis shows that subsidized housing has double the impact of market-rate development. Further, the effectiveness of market-rate housing in mitigating displacement seems to diminish as more market-rate housing is built in a subsequent decade. More research would be necessary to understand this phenomenon, but this result suggests that over time, the con-

struction of market-rate housing may have a catalytic effect on a neighborhood, increasing its attractiveness to upper-income residents, rather than a protective effect of filtering.

Housing Production May Not Reduce Displacement Pressure in a Neighborhood

As Rick Jacobus explains,[12] because market mechanisms work differently at different geographic scales, market-rate construction can simultaneously alleviate housing pressures across the region while also exacerbating them at the neighborhood level. At the regional scale, the interaction of supply and demand determines prices; producing more market-rate housing will result in decreased housing prices and reduce displacement pressures. At the local, neighborhood scale, however, new luxury buildings could change the perception of a neighborhood and send signals to the market that such neighborhoods are desirable and safer for wealthier residents, resulting in new demand. Given the unmet demand for real estate in certain neighborhoods, new construction could simply induce more in-moving.[13] By extension, then, one would expect market-rate development to reduce displacement at the regional scale but increase it or have no or a negative impact at the local neighborhood scale.

Here we test this hypothesis. We do this by analyzing our regional data set at the tract level[14] and comparing the results to the block group level for San Francisco,[15] where we have our most accurate data on housing production. What we find largely confirms this regional versus local argument; there is some, albeit limited evidence that at the regional level market-rate housing production is associated with reductions in the probability of displacement (Model 5), but at the block group level in San Francisco it has an insignificant effect (Table 4, Models 6). Comparing the effect of market-rate and subsidized housing at this smaller geography, we find that neither the development of market-rate nor subsidized housing has a significant impact on displacement. This suggests that indeed in San Francisco, and by extension similar strong markets, the unmet need for housing is so severe that production alone cannot solve the displacement problem.

To illustrate this point, in Figure 1 we plot on the X-axis construction of new market-rate units in the 1990s and 2000s and on the Y-axis the change in the number of low-income households from 2000 to 2013 for both tracts in the entire region and block groups in San Francisco. Although at the regional level the relationship between market-rate development and change in low-income households appears linear, the same is not true for the block group level, where no clear pattern emerges.

Table 4. The Impact of Market-Rate and Subsidized Developments on Displacement, San Francisco Block Groups, 1990-2000 and 2000-2013

	Model 6
% of housing units built pre-1950 in 2000	1.017***
% of population nonwhite in 2000	-2.306***
% of adult population with college degree in 2000	-0.427
Housing density (pop/square mile) in 2000	-1.0E-05***
% of households with income below 80% of county median in 2000	3.038***
Number of new market-rate units built between 1990-1999	-0.002
Number of subsidized units built between 1990-1999	-0.004
Number of new market-rate units built between 2000-2013	4.2E-04
Number of subsidized units built between 2000-2013	-0.001
Intercept	-0.638
n	578
Pseudo R^2	0.113
***<.01 **<.05 *<.10 significance level	

Housing Production and Neighborhood Change in SOMA, SF

To better grasp the complicated relationship between housing development and displacement at the local block group level we selected two case study areas in San Francisco's South of Market Area (SOMA) that experienced high rates of development of both market-rate and subsidized units since the 1990s, but had divergent results when it came to changes in the income profile of their residents. We examined the dynamics of block groups 2 and 3 in Census Tract 176.01. Both witnessed among the highest levels of housing construction in San Francisco for both market-rate and subsidized units, yet from 2000 to 2013 our data show that Block Group 2 gained low-income households and Block Group 3 lost low-income households.

Block Group 2

At the heart of downtown San Francisco, this seven-block area is home to nearly 2,500 residents today, nearly doubling its population since 2000. In the 1990s, 127 market-rate units were added to the area, mostly in mid-sized

Figure 1. Housing Production (1990-2013 and Change in Low-Income Households (2000-2013)

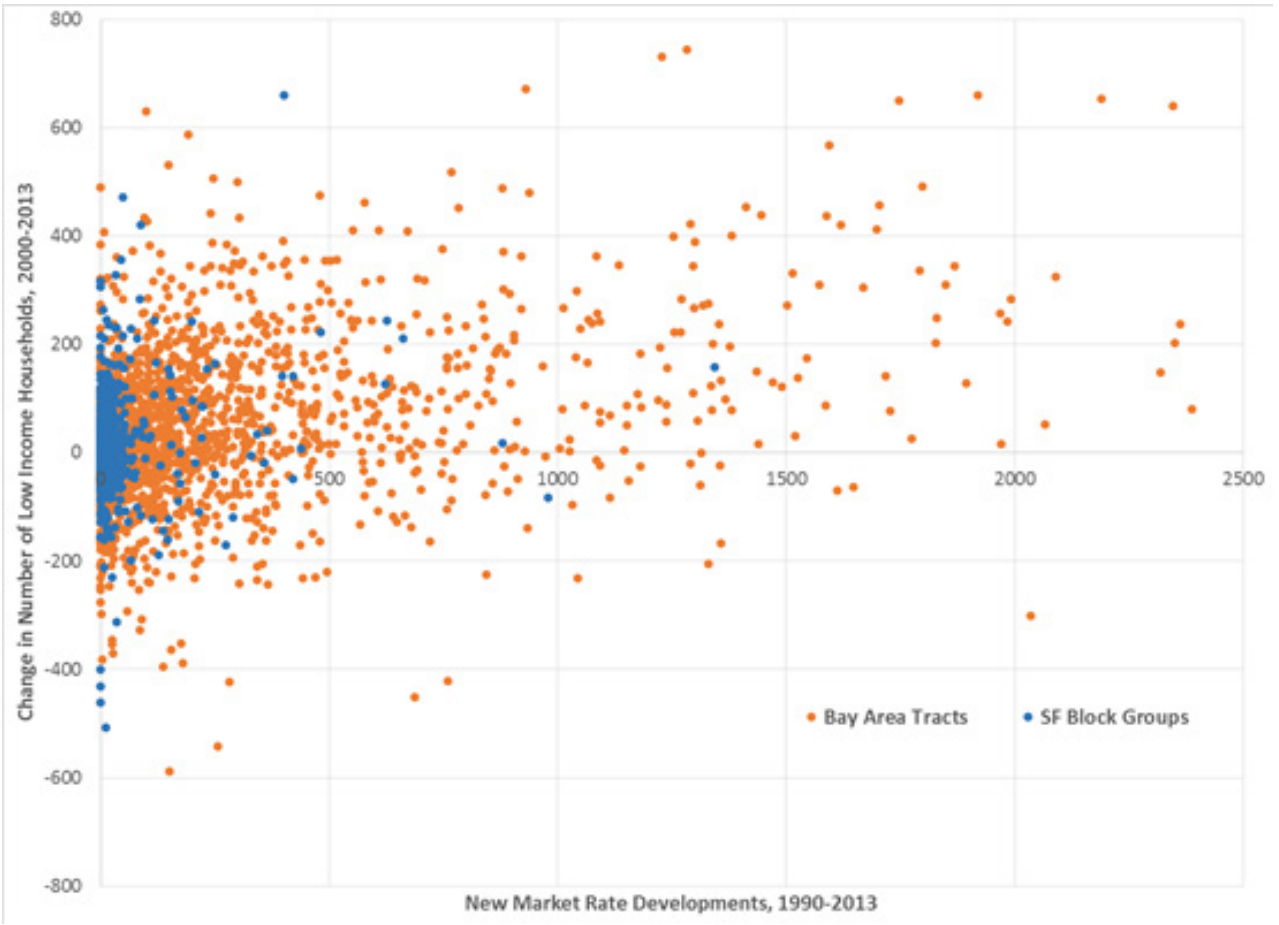
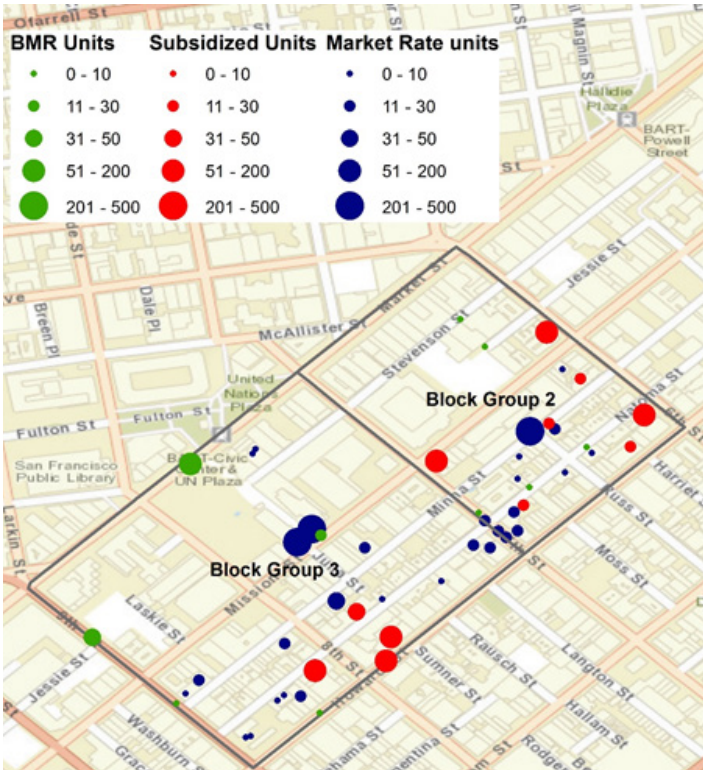


Figure 2. Housing Developments from 1990-2013 in Two Block Groups of the SOMA Neighborhood, SF



buildings of about 30 units. During that same period, 108 subsidized units were added, including 72 units in a single room occupancy (SRO) hotel. Sales prices for condos dipped in the mid-1990s, but climbed back to nearly $400 per square foot by 1999 (in 2010 dollars, see Figure 3).

Development of market-rate units continued into the early 2000s, when the 258-unit SOMA Residences apartments were built at 1045 Mission Street in 2001. Three below-market-rate units were developed as part of the city's inclusionary housing program, but no other subsidized units were added. Sales prices increased in the area in the early 2000s, suffered from the housing crisis in the mid-2000s, but reached back up to prerecession values by 2013.

Yet the area did not witness a significant loss of low-income households during the 13-year period of 2000 to 2013, which may be in part related to the fact that nearly a thousand units in the area are in buildings regulated by rent control (nearly 60% of all rental units), which has remained relatively constant since 2000. Finally, this area is bordered by 6th Street to the east, San Francisco's "skid row," with high rates of crime and concentrated poverty which may be dampening the attractiveness of the neighborhood. When we incorporate crime rates into our model, they significant-

Figure 3. Median Condo Sales Price per Square Foot, 1991-2013 (Source: Dataquick 2014)

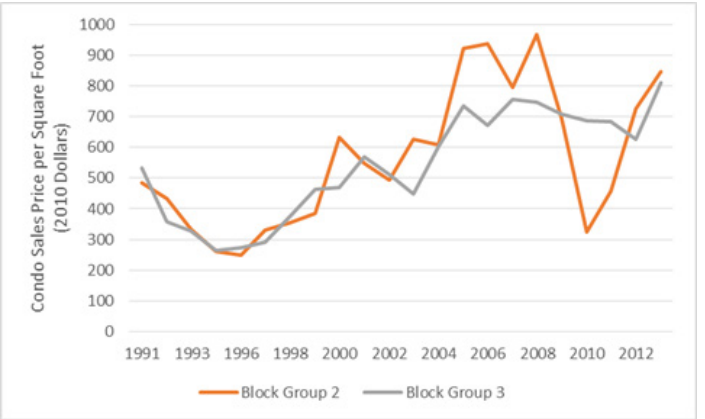


Figure 4. Canon Kip Community House Built in 1994 Houses Disabled Homeless Adults in 104 SRO Units

Figure 5. 440 Units Were Developed at Trinity Place, at 1188 Mission Street, in 2010

ly predict a reduction in displacement probability, even at the block group level, which housing production does not.

Block Group 3

Block Group 3 is an eight-block area centered to the north around the Civic Center BART station and home to over 2,100 people (Figure 2). The area gained 101 market-rate units and 104 subsidized units in the 1990s. This block group was the site of a 104-SRO-unit building for disabled homeless adults in 1994. The 101 market-rate units built in the 1990s were in smaller scale developments of 30 units or less. Development accelerated the following decade with 601 market-rate units and 315 subsidized and below-market units. In 2002, 48 units were developed at 675 Minna followed by 162 affordable units at 1188 Howard. In 2008, 244 luxury condos opened in the SOMA Grand at 1160 Mission and in 2010, following years of negotiation, the Trinity Management group opened 440 high-end furnished apartments at 1188 Mission as part of the Trinity Plaza development. The development was at the center of housing debates as it involved the demolition of 377 rent-controlled units. Ultimately the developer agreed to put 360 of its new 1,900 units under rent control.[16] In 2015, however, the management group was accused of renting out some of those rent-controlled units to tourists.[17] Overall the area lost approximately 40% of its rent-controlled housing stock since 2000 and today a little over half of the rental units are under rent control.

Despite the ongoing investments in subsidized housing in the neighborhood, the new high-end developments have contributed to the ongoing transformation of the neighborhood as characterized by the 2013 Yelp review by a SOMA Grand resident:

> I bought a place here in 2009 and absolutely love it. While the neighborhood might have a bit of grit to it there are so many great restaurants nearby, including the one right in the building. . . . This neighborhood is transforming fast too![18]

This, along with the loss of rent-controlled units, has resulted in a net loss over 150 low-income households (with median incomes between 50% and 80% of San Francisco median income) between 2000 and 2013. It is unclear, however, how much of that loss is due to the direct displacement from the Trinity development or from indirect displacement due to rising rents associated with local development or other factors affecting housing demand.

These two block groups illustrate the complex relationships between housing development and demographic change. While both neighborhoods have witnessed dramatic development in one of the fastest growing parts of San Francisco, and have similarly seen significant growth in housing prices, one may be classified as experiencing displacement of low-income households, while the other does not. The ambiguous effects of development at the local level carry over to affordability as well. In Table 5 we show the linear modeling results of housing development on median rent and housing cost burden for low-income households, finding that subsidized units built in the 2000s are associ-

Table 5. The Impact of Development on Median Rent and Housing Cost Burden for Low-Income Households for SF Block Groups (Linear Model)

	Median Rent (2009-2013)	Percent of Low Income Households that are Housing Cost Burdened (2009-2013)
% of housing units built pre-1950 in 2000	94.615	0.030
% of population nonwhite in 2000	-230.837	0.126
% of adult population with college degree in 2000	692.844**	0.113
Housing density (pop/square mile) in 2000	-5.2E-04	9.5E-08
% of households with income below 80% of county median in 2000	-616.005***	-0.109*
Number of new market-rate units built between 1990-2000	6.0E-01	-3.5E-05
Number of subsidized units built between 1990-2000	1.0E+00	2.6E-05
Number of new market-rate units built between 2000-2013	3.4E-02	1.5E-04*
Number of subsidized units built between 2000-2013	-9.1E-01**	-3.6E-04*
Intercept	1526.485***	0.590***
n	578	563
R^2	0.250	0.020

***<.01 **<.05 *<.10 significance level

ated with a decline in median rent and housing cost burden, whereas market-rate developments are associated with greater housing cost burden. Development of subsidized and market-rate units in the 1990s appears to have no significant impact on affordability in the subsequent decade at the block group level. As discussed above, housing affordability and displacement may be related to other neighborhood and regional factors, such as employment dynamics and neighborhood amenities that were not included in the models. Additional research will be needed with higher-resolution housing data along with other information about neighborhood amenities to better understand the dynamics and impact of housing production at the local scale.

Conclusions

There is no denying the desperate need for housing in California's coastal communities and similar housing markets around the U.S. Yet, while places like the Bay Area are suffering from ballooning housing prices that are affecting people at all income levels, the development of market-rate housing may not be the most effective tool to prevent the displacement of low-income residents from their neighborhoods, nor to increase affordability at the neighborhood scale.

Through our analysis, we found that both market-rate and subsidized housing development can reduce displacement pressures, but subsidized housing is twice as effective as market-rate development at the regional level. It is unclear, however, if subsidized housing production can have a protective effect on the neighborhood even for those not fortunate enough to live in the subsidized units themselves.

By looking at data from the region and drilling down to local case studies, we also see that the housing market dynamics and their impact on displacement operate differently at these different scales. Further research and more detailed data would be needed to better understand the mechanisms via which housing production affects neighborhood affordability and displacement pressures. We know that other neighborhood amenities such as parks, schools, and transit have a significant impact on housing demand and neighborhood change[19] and it will take additional research to better untangle the various processes at the local level.

In overheated markets like San Francisco, addressing the displacement crisis will require aggressive preservation strategies in addition to the development of subsidized and

market-rate housing, as building alone won't protect specific vulnerable neighborhoods and households. This does not mean that we should not continue and even accelerate building. However, to help stabilize existing communities we need to look beyond housing development alone to strategies that protect tenants and help them stay in their homes.

Technical Appendix

Data

We use the same dataset released on our website urbandisplacement.org as used in the LAO report. We add data on the production of subsidized units using data from the California Housing Partnership Corporation that compiled information from federal LIHTC and HUD subsidies, as well as California state subsidies.[20] We supplement this data with information for San Francisco on parcel level housing data and information on units produced under their Below Market-Rate (inclusionary housing) program.

Defining Displacement

For the purposes of comparison, we use the same definition of displacement as the LAO report. They defined a census tract as having experienced displacement if (1) its overall population increased and its population of low-income households decreased, or (2) its overall population decreased and the rate of low-income households declined at a faster rate than the overall population decline. The time period for change in low-income households is 2000 to 2013. We apply the same methodology for San Francisco block groups.

It's important to note the limitations of this data in proxying for displacement, as it is feasible that the change in low-income households is a result not only of people moving out and in, but also income mobility of households moving down and becoming low income or up and becoming higher income. From our analysis of data from the Panel Study on Income Dynamics we estimate that there would have been a net increase in low-income households in most places from 2000 to 2013 likely due to the Great Recession; therefore, our estimates of displacement are likely an underestimate. Ideally we would be able to more accurately proxy for displacement by using a measure of out-migration of low-income households from a tract. Future research is needed accessing mobility datasets to better capture the displacement phenomenon for the Bay Area.

Sensitivity Analysis

In their response to the LAO Report, Alex Karner and Chris Benner argued that the LAO results may be due to lumping together the major cities and low-density suburbs into the same analysis.[21] Although the inclusion of density should account for such differences, there may be additional impacts from centrality of location. When we control for location in the three major cities (San Francisco, Oakland, and San Jose), the effect of market-rate housing remains, but so too does the magnitude of the effect of subsidized housing[22] (Table 6, City Controls Model). In other words, all locations being equal, subsidized housing still has a greater impact.

It has also been suggested that the results may be driven by neighborhood distress during the foreclosure crisis where greater evictions occurred or fewer market rate units were developed. To test this hypothesis, we controlled for foreclosure rates between 2006 and 2013, finding the results to be robust (Table 6, Distressed Tracts Model).

Finally, the categorical indicator developed by the LAO could feasibly be labeling neighborhoods as experiencing displacement that are in fact a result of other issues of decline such as high rates of foreclosures. We originally attempted to control for this by excluding tracts that had experienced overall population decline, however it is feasible that gentrifying neighborhoods that witness a shift from family to smaller households could also experience population decline. For this reason, we deemed the LAO definition of displacement acceptable for the purposes of this analysis. Nevertheless, we also ran a set of tests using a modified indicator that only counted tracts that grew from 2000-2013 as potentially experiencing displacement and also ran linear regression models on the change of low income households. When we did this, the direction and implications of the results remained the same.

Notes

1. Brian Uhler, "Perspectives on Helping Low-Income Californians Afford Housing," LAO Brief (Legislative Analyst's Office, February 9, 2016). Data available at <urbandisplacement.org>.

2. Michael Smith-Heimer, "The Potential for Filtering as Public Policy," *Berkeley Planning Journal* 5, no. 1 (1990): 94–104.

3. Stuart S. Rosenthal, "Are Private Markets and Filtering a Viable Source of Low-Income Housing? Estimates from a 'Repeat Income' Model †," *American Economic Review* 104, no. 2 (February 2014): 687–706, doi:10.1257/aer.104.2.687.

4. For rentals, Rosenthal estimates that filtering rate = -0.0237 + 0.2522 x housing price appreciation.

5. Allowing for annual compounding effects assuming a constant annual filtering rate of 1.5%, the amount a unit would filter down in X years is calculated as (1-0.015) X.

6. See Emily Badger, "How to Make Expensive Cities Affordable for Everyone Again," *Washington Post* (February 19, 2016). Accessed at <https://www.washingtonpost.com/news/wonk/wp/2016/02/19/how-to-make-expensive-cities-affordable-for-everyone-again/>.

7. This is perhaps unsurprising, since we did not publish this data online.

8. Note the coefficients of Model 1 do not match identically those of Figure A1 in the LAO report. The year of the independent variables used for the LAO model were not indicated. We tried

Table 6. Sensitivity Analysis of Regional Displacement Model		
	City Controls Model	Distressed Tracts Model
% of housing units built pre-1950 in 2000	0.517**	0.517**
% of population nonwhite in 2000	-0.887***	-0.880***
% of adult population with college degree in 2000	1.840***	1.817***
Housing density (pop/square mile) in 2000	-8.82E-06**	-8.87E-06**
% of households with income below 80% of county median in 2000	3.005***	2.992***
Number of new market-rate units built between 2000-2013	-0.002***	-0.002***
Number of subsidized units built between 2000-2013	-0.005***	-0.005***
San Francisco control	-0.102	-0.104
San Jose control	-0.121	-0.124
Oakland control	-0.067	-0.067
Foreclosure rate, 2006-2013		-0.262
Intercept	-1.715***	-1.697***
n	1569	1569
Pseudo R^2	0.172	0.172
***<.01 **<.05 *<.10 significance level		

both variables for 2000 and 2013, but were unable to replicate the coefficients identically. Nevertheless, the coefficient for market rate housing production is very similar to that produced in the LAO model and the other variables have similar results in scale, directionality, and significance.

9. Lance Freeman, "Displacement or Succession? Residential Mobility in Gentrifying Neighborhoods," *Urban Affairs Review* 40, no. 4 (March 2005): 463–91.

10. We do not analyze units developed with local funding only (e.g., Redevelopment money or through inclusionary zoning) due to lack of availability for the entire region

11. These relationships were robust for several other measures of displacement we tested including the absolute change in low-income households.

12. Rick Jacobus, "Why We Must Build," *Shelterforce*, March 9, 2016, <http://www.shelterforce.org/article/4408/why_we_must_build/>.

13. Karen Chapple and Mitchell Crispell, "Mission Accomplished? Revisiting the Solutions," November 9, 2015, <http://www.urbandisplacement.org/blog/mission-accomplished-revisiting-solutions>.

14. On average in the Bay Area tracts have 1,656 households (min=15, max=6474) and 4,593 people (min 39, max 13,855).

15. On average in SF block groups have 603 households (min-41, max=4,082) and 1,434 people (min=45, max=8,621).

16. Randy Shaw, "Historic Trinity Plaza Deal Finalized," *Beyond Chron*, June 9, 2005.

17. Laura Dudnick, "Trinity Place Developer Accused of Illegally Leasing Apartments," *San Francisco Examiner*, August 6, 2015.

18. "SOMA Grand Residential Condos - SoMa - San Francisco, CA," Yelp, accessed May 2, 2016, <http://www.yelp.com/biz/soma-grand-residential-condos-san-francisco>.

19. Miriam Zuk et al., "Gentrification, Displacement, and the Role of Public Investment: A Literature Review," Working Paper (Federal Reserve Bank of San Francisco, August 24, 2015), <http://www.frbsf.org/community-development/publications/working-papers/2015/august/gentrification-displacement-role-of-public-investment/>.

20. <http://chpc.net/advocacy-research/preservation/preservation-database/>.

21. Cities that produce a lot of market-rate housing and experience high displacement pressures with places in the suburbs and urban fringe where there has been a lot of construction but little displacement pressure.

22. The same is true if we restrict our analysis only to census tracts with above average density. The effect is also consistent when we control for tracts that gentrified in either decade (149 tracts).