

**LA Multifamily Housing: obstacles to the adoption of off-site construction
as a method of increasing production**

A doctoral dissertation
by
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and
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Signature Page

LA Multifamily Housing: obstacles to the adoption of off-site construction as a method of
increasing production

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The thesis of Brent Musson, directed and approved by the candidate's Committee, has been
accepted by the Faculty of the College of Professional Studies, Doctor of Law and Policy
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Without the support of my wife, Japhena, and my son, Austin, my research would not have been possible. Thank you for believing in me enough to believe in my dreams.

My brother Bryan and I were fortunate to be raised by parents who taught us to believe in ourselves but to believe in God even more. Thank you, Mom and Dad (Joan and Cyril Musson)!

During the course of my research our family suffered the devastating loss of our younger son, Austin's little brother Chase. He and I began our doctoral journeys together in the same year; a journey I never expected to finish without him. My research is dedicated to my beloved son, Chase Ryker Musson.

Dean's Medal for Outstanding Doctoral Work

Dr. Brent Musson, graduate of the Doctor of Law and Policy program, is the recipient of the college's highest academic honor, the Dean's Medal for Outstanding Doctoral Work for his thesis, "L.A. Multifamily Housing: Obstacles to the Adoption of Off-Site Construction as a Method of Increasing Production."

The founder of innovative industrialized construction company MUSSON Factory, Dr. Musson is a certified Project Management Professional (PMP)®, a Lean Six Sigma Green Belt, licensed real estate broker, and general contractor. He holds degrees in real estate development, urban planning, and supply chain management from the University of Southern California, and he has been a consultant to the international real estate development industry for two decades, providing global supply-chain management, asset management, project management, and program management to projects on three continents. Dr. Musson also served three terms in policymaking roles as Councilman in Altadena, CA; as a member of its Land Use Committee, and on the West Altadena Project Area Committee. As a keynote speaker or featured guest, he has shared his expertise in real estate finance, project management, international best practices, global logistics, and continuous improvement strategies with audiences across the globe.

Dr. Musson's research, which has produced two pending patents, explores the industrialization of multifamily housing development. According to Dr. Musson's thesis advisor and professor, Ivan Rupnik, Ph.D., Associate Professor at Northeastern's College of Arts Media and Design and Lecturer, Northeastern's College of Professional Studies, Dr. Musson "was able to build upon a national survey I conducted of obstacles to off-site construction (OSC), crafting

his own interviews for major stakeholders involved in housing delivery in Los Angeles. Working closely with Professor Gary Painter, an economist from USC, he was also able to adapt an economics theory to help him assess his findings. His dissertation was therefore truly interdisciplinary and, more importantly, will help address real societal issues facing U.S. cities.”

Dr. Musson writes in his thesis abstract that his study examines “the obstacles to the adoption of OSC in Los Angeles through the theoretical framework of oligopoly theory, a current macro-economic framework that offers an explanation as to why key housing production actors might be motivated to limit the supply of housing during a housing shortage.” He goes on to explain that “this study is the first to examine OSC through the lens of the housing crisis as an economic market failure and contributes to the body of knowledge regarding the obstacles to the adoption of OSC. It examines the motives of the decisionmakers that set housing production levels by either exploiting OSC to boost production or by acting as a bottleneck impediment to OSC housing production in the LA Metro area.”

Dr. Rupnik called Dr. Musson someone who “epitomizes the greatest potential of Northeastern University, the College of Professional Studies, and the Doctorate of Law and Policy, bringing real-world experience and problems and leaving the program with a new set of skills that he will, in turn, directly apply to the betterment of those who need it most—the most impoverished members of society.”

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Abstract

Los Angeles Metro, like many other U.S. metropolitan regions, currently suffers from a shortage of housing and a lack of housing affordability. The application of off-site construction (OSC), an industrialized production method, has been recognized as one potential solution to these problems, but adoption has remained low, despite a consensus opinion that this means of housing delivery has the potential to address both issues facing the region. This dissertation has examined the obstacles to the adoption of OSC in Los Angeles through the theoretical framework of oligopoly theory, a current macro-economic framework that offers an explanation as to why key housing production actors might be motivated to limit the supply of housing during a housing shortage. This theory was tested in the Los Angeles Metro market using qualitative data collected from the top-6 most prolific incumbent multifamily landlords. Findings include persuasive data that disqualify oligopoly as a viable theoretical framework within which to understand OSC's poor adoption or the current housing shortage and affordability crisis in the Los Angeles Metro region. This study is the first to examine OSC through the lens of the housing crisis as an economic market failure and contributes to the body of knowledge regarding the obstacles to the adoption of OSC. It examines the motives of the decisionmakers that set housing production levels by either exploiting OSC to boost production or by acting as a bottleneck impediment to OSC housing production in the LA Metro area.

1. Introduction

1.1. Recognizing the Challenge

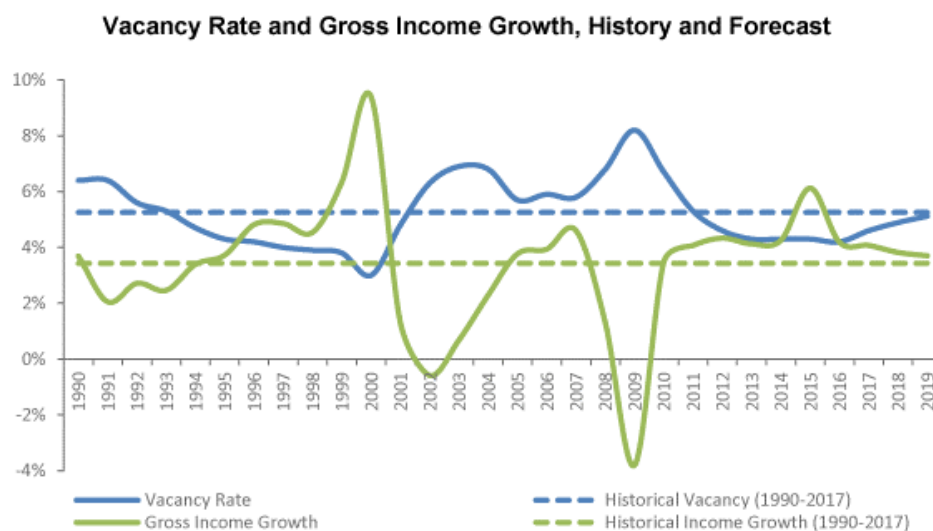


Figure 1

The Los Angeles Metro region suffers from a chronic shortage of housing and notoriously high housing costs. “Los Angeles, California, is in the midst of an affordable housing crisis. Rents increased by 7.3% in 2014 alone, and the median renting household already spends 47% of its income on housing” (Lee, 2016, p. 229). The LA area ranks in the top-five most expensive rental markets in the United States along with the Bay Area, New York, Boston, and Washington DC (Renzulli 2016). Even still occupancy is above 95% (*FreddieMac Multifamily 2019 Outlook*, 2019; K. Smith, 2017). In 2017 Freddie Mac forecasted vacancy under 4% by 2019 (see *Figure 1*) but the actual data collected in 2019 reveals an even tighter ratio. Harvard University Joint Center for Housing Studies tabulations of RealPage (MPF) market data show that vacancy in Los Angeles plummeted from roughly 6% to 2% in just five years (Gabriel & Painter, 2018, p. 2).

Quarterly Vacancy and Homeownership Rates data from the U.S. Census

(tab_msa_15_19_rvr.xlsx) shows first quarter 2019 at 3.6% for the MSA comprising two LA County cities and one from Orange County: Los Angeles, Long Beach, and Anaheim ("U.S. Census," 2017, current online data retrieved from <https://www.census.gov/housing/hvs/data/rates.html>).

A 2015 report by the Joint Center for Housing Studies of Harvard University breaks down housing cost burden by city and shows that, in Los Angeles, over 57% of renters were cost burdened (paying >30% of income on housing) and almost 30% were severely cost burdened (paying >50% of income on housing). The cost burden percentage in Los Angeles was the second-highest, behind South Florida at 61.5%, but it wasn't an outlier—New York and Chicago also show cost burden percentages over 50%—in fact, the top 30 metropolitan districts, ranked by cost burden, post at least 50% housing cost burden. The top 100 cities range from roughly 40-60% cost burdened ("Millions of Americans Burdened by Housing Costs in 2015," 2015). "Housing

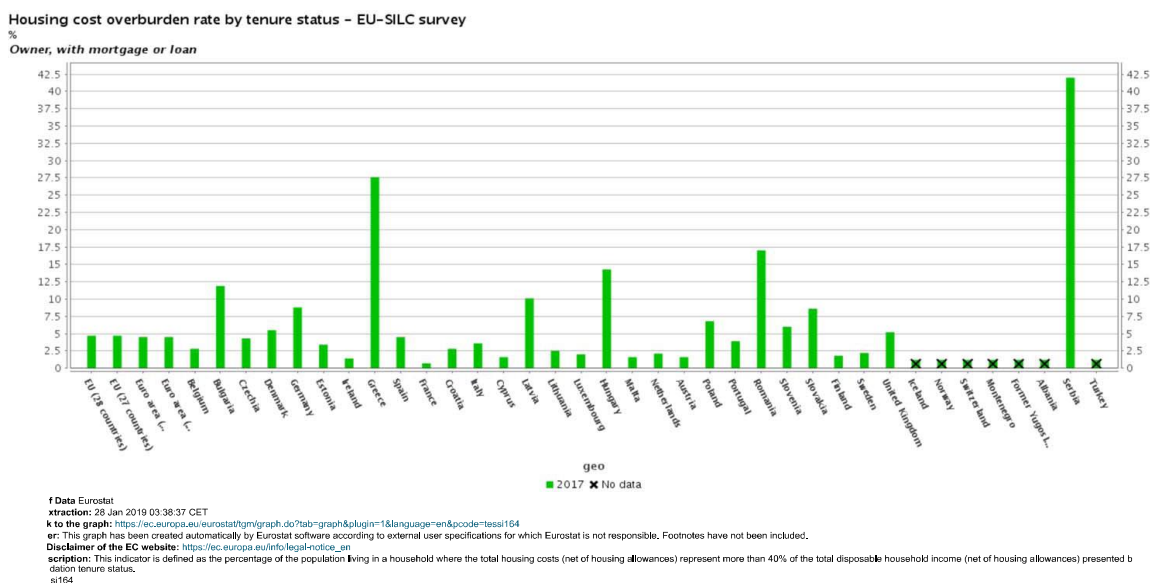


Figure 2

affordability dropped this quarter to the lowest since late 2008, according to data released this month [pub. June 20, 2018] by the National Association of Realtors” (Tanzi, 2018).

The European Union defines cost burden as a household spending >40% of income on housing, while the U.S. pegs the percentage at >30%; though the comparison is not perfectly congruous, E.U. countries’ cost burden frequency doesn’t approach that in the U.S. Contrasted with over 50% in the U.S., across the E.U. rent burden averages 4.7% (see *Figure 2*); the U.K. reports 5.2%, Germany reports 8.8%, and France reports 0.7%; Greece and Serbia are outliers at 27.6% and 42.0% respectively (“Housing cost overburden rate by tenure status - EU-SILC survey,” 2019). The wide disparity between the E.U.’s 4.7% and the U.S.’s 57% demonstrates that the housing affordability crisis in the U.S. is far more acute than in the European Union.

1.1.1. Housing Shortage

One of the characteristics of California’s housing crisis is simply a shortage of available housing. “Over the past three decades, California has added only about half the number of units it needs to keep housing costs in line with the rest of the United States. Between 1980 and 2010, the number of housing units in the typical U.S. metro grew by 54 percent, compared with 32 percent for California's coastal metros” (Reid, Galante, & Weinstein-Carnes, 2017, p. 1).

One contributing factor to California’s housing shortage may be a shortage of workers. Twenty years ago a shortage of skilled construction labor was already well-documented, “In a 1997 study conducted by the National Center for Construction Education and Research (NCCER), they found that 92% of national construction firms reported shortages of skilled labor, and over 85% of those

surveyed said their current workforce is not as skilled as it should be in today's market (Shelar, 1998)" (Chini, Brown, & Drummond, 1999, p. 2). Two decades later, the problem persists. "Findings from the Q2 2018 USG Corporation + U.S. Chamber of Commerce Commercial Construction Index (Index), released, show four straight quarters with more than 90 percent of contractors concerned over labor shortages." And "47 percent of respondents expect problems finding skilled workers to worsen in the next six months" ("Workforce Challenges Continue to Impact Construction Industry as 9 out of 10 U.S. Contractors Report Skilled Labor Shortage," 2018, p. 1). "According to Forbes and a host of other news outlets, a serious gap exists between the upcoming demand for labor and the number of available workers with the skills needed to fill those positions." (*Skilled Labor Shortage Risk Mitigation*, 2015, p. 1). "The labor shortage is hitting California hard. A report released earlier this year by the Associated General Contractors of America found that 62 percent of California contractors are struggling to fill both salaried and craft worker positions" and unfortunately "A 2017 Builder magazine poll of young people ages 18 to 25 found that, of those who knew what they wanted to do, only 3 percent were interested in the construction trades" (Hakel, 2018, p. 1), and following the Great Recession, "It's likely that many former workers, facing the loss of wages and benefits, have opted for new careers and won't be coming back" (*Skilled Labor Shortage Risk Mitigation*, 2015, p. 1).

The trending reduction in skilled construction labor refers to tradespersons within the traditional in situ construction labor pool, but the latest Los Angeles

County and City of LA joint jobs report, published by the Institute for Applied Economics at the LACEDC charts steady population growth of about 2% per year and a blue collar unemployment rate of around 10%, which is more than double the 2006 unemployment rate (Cooper & Sedgwick, 2015, pp. 2, 8, 15), so there is an available labor force for entry-level manufacturing jobs (typical for an off-site construction factory), even in a climate with limited skilled construction labor.

1.1.2. Housing Affordability

Housing in California is not only scarce, but also unaffordable.

“California, particularly in its coastal cities, is facing a housing affordability crisis. Median rents across the state have increased 24 percent since 2000, while at the same time median renter household incomes have declined 7 percent. While multiple factors contribute to these rising rents, it is clear that supply matters, and there is an urgent need to expand supply in equitable and environmentally sustainable ways” (Reid et al., 2017, p. 1). “No other state faces a housing shortage as deep and wide as California. Fees, regulations and delays have pushed building costs to among the highest in the nation, and the state adds far fewer new units than it needs each year to meet demand. As a result, median home prices have about doubled since the end of the Great Recession, to \$558,000” (Blumberg & Varghese, 2019, p. 2). Affluent communities actively resist Sacramento’s mandate for local municipalities to accommodate increased density; in fact, one city’s resistance to state density quotas has made it a defendant in a lawsuit filed by the state in January 2019. “California’s leaders sued the seaside city of Huntington Beach over claims that it worsened the state’s

housing shortage by refusing to cooperate with a plan for more affordable units” (Blumberg & Varghese, 2019, p. 1).

California State Senator Scott Wiener is quoted, “We’re at a breaking point in California [...] This is no longer a coastal, elite housing problem. This is a problem in big swaths of the state. It is damaging the economy. It is damaging the environment, as people get pushed into longer commutes” (Nagourney & Dougherty, 2017). ““There is a consensus that there is a crisis and we have to address it,’ said David Chiu, a San Francisco Democrat who leads the Assembly Housing and Community Development Committee” (Nagourney & Dougherty, 2017). The Regional Housing Needs Assessment white paper from LA’s Central City Association states, “Housing is the most important issue we can tackle to support livability and investment in Los Angeles. Far too many Angelenos are rent burdened, and thousands of residents are being pushed into homelessness each year by rising rents and home prices” (Lall, Rumsey, Phillips, & Oh, 2018). Housing unaffordability has become one of the most salient policy issues in the state, so much so that on September 29, 2017 Governor Brown signed a bundle of 15 housing affordability bills into law.

The cost of producing housing is one of the primary inputs to the consumer cost of housing. “Construction sites are variable environments experiencing [1] inclement weather conditions, [2] quality problems resulting in rework, and [3] shortage of specialized subcontractors. The variability results in time and budget overruns, which are endemic problems in construction projects” (Arashpour, Wakefield, Blismas, & Minas, 2015, p. 72). “Offsite construction -

the prefabrication, modularization and standardization of construction processes and assets within controlled factory environments - continues to be quoted across government and industry as a potential catalyst in meeting these challenges” (Threlfall, 2016, p. 4).

The construction industry, however, has failed to adopt the greater efficiencies of manufacturing best practices. Big-5 consulting firm, McKinsey, claims, “The seven areas that need to be addressed can boost productivity by some 50 to 60 percent.” (Bughin, Manyika, & Woetzel, 2017, p. 115). Except for replacing hammers with pneumatic nail guns and electrifying saws, etc., American construction methodology has not improved since Bill Levitt, father of the suburb, built his first Levittown in the 1950s (Allen, 1996, p. 157). In fact, “construction labor productivity has declined by an average of 1.7 percent a year since 1968 while the productivity of the overall economy has grown by 1.6 percent over the same period” (Bughin et al., 2017, p. 22).

“McKinsey has estimated that repeatable components and prefabrication in the industrial segment can generate an increase of 20 to 30 percent in value. In a McGraw-Hill survey, 6 percent of firms that used prefabrication and modularization reported a reduction in schedules, and 42 percent reported a reduction in cost of 6 percent or more” (Bughin et al., 2017, p. 116). and, “Time can be further optimized by integrating off-site construction with lean construction processes” (*EY - Construction sector transformation: The productivity drivers*, 2018).

The Los Angeles Metro region may not see relief from its housing woes until the cost of producing housing drops relative to the market-rate demand; the category where most housing enters the market before deteriorating into downstream, affordable, moderate-income, and low-income categories. But if real estate development becomes more efficient, e.g., adopts industrialization strategy i.e., OSC, more housing could be produced and housing production cost could be more controllable, leading to lower housing cost, and more housing availability.

1.2. Existing Policy Solutions

Two primary means by which California actively encourages housing production are regulation and subsidies. Subsidies are applied, primarily, to low-income housing; regulation has been used historically by local governments to compel developers to include affordable housing in new developments. Subsidies typically take the form of tax breaks that create incentives, for investors and developers to build a quota of low-income housing units into their projects. The tax incentive can be sold to investors as an enticement to participate in low-income projects.

[...]an LIHTC [Low-income Housing Tax Credit] project by itself will typically not create a sufficient tax liability for its owner to claim the full value of the subsidy given the program's limits on tenant rents. This characteristic of the program has led to virtually all developers immediately selling the equity (bundled with the tax credits) of their subsidized projects immediately after construction to a secondary market of investors with a projected sufficient tax liability (Eriksen, 2009, p. 144).

“Congress created the federal Low-income Housing Tax Credit Program in 1986. It replaced traditional housing tax incentives, such as accelerated depreciation, with a tax credit that enables low-income housing sponsors and developers to raise project equity through the sale of tax benefits to investors” (Chiang, Yee, Cohen, & Stevens, 2015). The Low-income Housing Tax Credit was part of a massive tax reform initiative by President Ronald Reagan. It was mostly in the form of tax reduction for businesses and the wealthy that began with the Omnibus Budget Reconciliation Act of 1981. This legislation included additional legislation, one of which was the Tax Reform Act of 1986 (TRA) within the larger Omnibus Budget Reconciliation Act of 1986. Another Omnibus Budget Reconciliation Act in 1987, was extended into the George H. W. Bush administration with further reconciliation through 1989, and 1990 before President Bill Clinton rolled back certain cuts to balance the budget in 1993. Reagan’s tax reforms also increased the Home Mortgage Interest Deduction, which set the current climate of tax incentive for home ownership. It effectively converted long-term capital gains into ordinary income for tax purposes. Low-income developers still take advantage of TRA provisions as well as the federal Low-Income Housing Tax Credit Program (1986). There’s more than one type of federal tax credit. Developers know them as the 9% and the 4% credits. “These terms refer to the approximate percentage of a project’s ‘qualified basis’ a taxpayer may deduct from their annual federal tax liability in each of ten years” (Chiang et al., 2015). These federal tax incentives have been in place for almost four decades with no appreciable increase in housing availability, as indicated by a vacancy rate that’s almost half of what it was ten years ago (see *Figure 1*).

The most recent incentive to encourage development is not housing-specific. In November of 2018, the Congressional Research Service distributed its brief explaining a new program, P.L. 115-97, commonly known as the Opportunity Zone (OZ). “The tax savings potential for such investments is huge. If the investor holds the fund for at least seven years prior to December 21, 2026, not only is the gain deferred but 15 percent of the gain would escape tax forever. And, if the investor holds the property for at least 10 years, in addition to the deferral of the original gain, all gain with respect to the investment will not be subject to tax” (Fichtenbaum, 2018, p. 48). The new legislation amends Internal Revenue Code (IRC) Sections 1400Z-1 and 1400Z-2. Governors are empowered to designate a limited number of census tracts within their states as Opportunity Zones which carry tax benefits designed to encourage investment. Some rules apply to help direct the designations to low-income tracts, but some flexibility is also allowed. The tax benefits are as follows:

1. *Temporary deferral of capital gains that are reinvested in qualified OZ property:* Taxpayers can defer capital gains tax due upon sale or disposition of a (presumably non-OZ) asset if the capital gain portion of that asset is reinvested within 180 days in a Qualified Opportunity Fund (QOF).
2. *Step-up in basis for investments held in QOFs:* If the investment in the QOF is held by the taxpayer for at least five years, the basis on the original gain is increased by 10% of the original gain. If the OZ asset or investment is held by the taxpayer for at least seven years, the basis on the original gain is increased by an additional 5% of the original gain.

3. *Exclusion of capital gains tax on qualified OZ investment returns held for at least 10 years:* The basis of investments maintained (a) for at least 10 years and (b) until at least December 31, 2026, will be eligible to be marked up to the fair market value of such investment on the date the investment is sold. Effectively, this amounts to an exclusion of capital gains tax on any gains earned from the investment in the QOF (over 10 years) when the investment is sold or disposed.

(Tax incentives for opportunity zones : in brief, 2018)

“Basically, an investor can defer the recognition of any gain recognized from the sale or exchange of any property to an unrelated party, if the amount of the gain is reinvested in a qualified opportunity fund within 180 days after the sale of such property. The gain on qualifying sales will be deferred until the earlier of (1) the date on which the investment in the fund is sold, or (2) December 31, 2026. [...] In addition to the deferral described above, the amount of gain to be recognized may be decreased as well”
(Fichtenbaum, 2018, pp. 47, 48).

The regulatory environment in Los Angeles does not specifically promote or encourage off-site, modular construction but has been permissive of it, as demonstrated by the 2014 completion of the Star Apartments development, a 95,000 sf, mixed-use, modular apartment and retail complex in downtown Los Angeles (Maltzan, 2014). An unfriendly regulatory environment could wreak havoc on a real estate development project’s financial proforma by delaying a project, levying unexpected fees and incurring costly outside consulting, thus making the project financially inviable. But a local non-profit, Skid Row Housing Trust’s Star Apartments is evidence that off-site projects can

be successfully built in LA; in fact, it's an award-winning, LEED Platinum, permanent supportive housing estate, completed at a below-market cost of \$203/sqft. (Maltzan, 2014). Cost and time were key decision variables for the developer. "Faced with a limited budget and tight schedule the design team determined that prefabricated modules lifted into place over the existing podium would help provide a higher quality of construction, meet tighter construction tolerances, accelerate construction time, and accomplish the project's ambitious sustainability goals" (Maltzan, 2014).

Almost any law or administrative agency rule that touches finance, land use, and licensed professions like construction, real estate, or lending has an impact on housing production and real estate development in general because development is a compounded process that combines all of these aspects through a unitary, sophisticated process. Some of the recent legislation that impacts development directly are SB 35, SB 166, AB 1397; and there are also other major laws that help to shape the environment as well: LIHTC, California Labor Code part 7, Immigration Reform and Control Act of 1986, and Deferred Action for Childhood Arrivals (DACA).

California State Senator Scott Wiener's bill, SB 50, is intended to increase development around transit hubs by substituting local entitlement authority with state authority. Despite sponsorship from California YIMBY, and co-sponsorship from the California Association of Realtors and Non-Profit Housing Association of Northern California (NPH), Sen. Anthony Portantino, chairman of the Senate Appropriations Committee, removed SB 50 from debate, so it's currently stalled but not technically dead. SB 35, SB 166, and AB 1397 were signed into law in 2017 and impact the real estate development industry in interrelated ways. They all help to lubricate new

development at the local government level, with the weight of the state behind the developer rather than behind the entitlement agency. Any legislation that eases regulatory impediments to the real estate development industry is expected to increase the volume of development; but there are other powerful forces that constrain development volume. Before a developer will initiate a project, the opportunity must be both attractive to the other equity and debt stakeholders and profitable for the developer (Brueggeman & Fisher, 2011). Lenders and investors are very selective when they make decisions to finance projects. Not every proposal represents a profitable opportunity; financiers invest in projects to earn profits, but they must also evaluate how time and risk impact value (Ling & Archer, 2010). Lenders must anticipate problems, calculate risk and adjust Return on Investment (ROI) projections based on these factors.

Production costs are high, even though some of the labor may be performed by undocumented laborers whose labor rates can be substantially lower than unionized American labor. Decades ago, President Ronald Reagan signed The Immigration Reform and Control Act of 1986, which reset immigration laws for millions of undocumented workers already in the U.S. by granting amnesty, while simultaneously committing to stop the influx at the southern border. “For 20 years our country has done basically nothing to enforce the 1986 regulation against either the employers who hired illegal immigrants or those who crossed our borders illegally to work for them” (Weiner, 2013). Currently “There are 11 million undocumented immigrants in the U.S.” (Siegel, 2017), including those employed in the construction industry. In a political climate that can be hostile to immigrant labor, production costs threaten to increase and possibly exacerbate the housing crisis.

Of particular concern is the threat to DACA. Undocumented workers in the construction field enjoy unprecedented access to education under DACA. 65% of DACA recipients are currently in school, and 92% of them are “pursuing educational opportunities they previously could not” (Richmond, Soler, Thompson, Stewart, & Tabe, 2018). Assuming that more educated DACA recipients in the construction industry would portend a more capable, and more efficient workforce; contrarywise, rescinding DACA would portend a less educated, less capable, and less efficient workforce.

Simultaneously, prevailing wages are increasing for legalized workers (“Index 2017-2 general prevailing wage journeyman determinations,” 2017). Updates to the California Labor Code, Part 7 on February 22, 2017, apply selective increases to prevailing wages. “The prevailing wage rate is the basic hourly rate paid on public works projects to a majority of workers engaged in a particular craft, classification or type of work within the locality and in the nearest labor market area (if a majority of such workers are paid at a single rate). If there is no single rate paid to a majority, then the single or modal rate being paid to the greater number of workers is prevailing” (“Frequently asked questions-Prevailing Wage,” 2018). Though prevailing wages are prescribed specifically for public works projects, many jurisdictions also require prevailing wages on non-union construction jobs over a specified size. The increases apply to various trades differently in different California regions. Many of the tradespersons with prevailing wage increases are directly related to new housing construction including: *carpenter, inspector, cement mason, drywall installer, elevator constructor, laborer, etc.* The combined impact of a less efficient workforce and higher

labor costs could elevate housing production costs and exacerbate the Los Angeles housing crisis.

1.3. Existing Real Estate Development Regulation

1.3.1. Regulations for all Real Estate Developers

Real estate developers are specifically regulated, in their construction practice, by the California Building Code which regulates all construction in the State of California. The Building Code specifies safety features including mandatory smoke detectors and sprinkler systems, insulation requirements, minimum room dimensions ("2016 California Building Code, California Code of Regulations, Title 24, Volume 1 of Part 2," 2016, pp. 135, 236, 635), etc. The Code is over 700 pages of specific parameters for building construction in California.

Besides the Building Code, developers are also subject to all of the tax laws and other rules that regulate any business in the state. Once the development phase is complete, the operation of the building involves activities that are mostly regulated by various departments under the California Business, Consumer Services and Housing Agency, which includes in its purview the California Housing Finance Agency (CalHFA), Department of Housing & Community Development (HCD), Department of Fair Employment & Housing (DFEH), Department of Business Oversight (DBO), and the Department of Real Estate (DRE) ("California Business, Consumer Services and Housing Agency," 2019).

Each of these departments regulates real estate developers based on specific sections of California law or manages a targeted service. CalHFA acts as

a state bank which underwrites low-interest loans and HCD makes grants and funds research related to low-income housing needs. The DBO, DFEH, and the DRE wield the State's police power to regulate real estate finance, civil rights, and real estate brokerage functions which include purchase and sale of real property, leasing agreements, property management, and loan brokerage, respectively—all of which relate to the management of a finished real estate development asset.

1.3.2. Regulations Specific to Off-site Development

1.3.2.1. Regulations Relevant to the Off-site Builder

Off-site construction is a method to erect a building—it is not a discrete building type; so, like regulation of in situ construction, regulation of off-site construction controls the building process, rather than the finished building itself.

Buildings erected using the off-site method are built to the same building code as buildings erected using a conventional, in situ, series of trades. However, code enforcement agencies inspect and approve on-site projects throughout the construction cycle using a series of site inspections as milestone gateways ("LA County DBS, inspections," 2019; "LA DBS, About the Construction Process," 2019). This protocol of site inspections is well-suited for site-built structures, but in practical terms, incompatible with the off-site method.

The off-site construction methodology is also the method of choice for a different category of housing that is not built under local building

codes. This different category of housing is identified by the U.S. Department of Housing and Urban Development (HUD) as *manufactured housing*, also commonly called *mobile homes* or *trailer homes*. Manufactured homes are built to a national code commonly referred to as the HUD Code ("USCODE, Title 42, Ch. 70: MANUFACTURED HOME CONSTRUCTION AND SAFETY STANDARDS," 1974).

Buildings that are constructed off-site, transported to the jobsite, and assembled are land improvement and become real property when attached to the Earth via a foundation and footing. Manufactured homes, which are also made off-site, are transported to a site and parked—they are not permanently attached to the Earth and remain chattel without becoming real property.

1.3.2.2. Regulations Relevant to the Off-site Developer

The primary law that protects building contractors in California is found in Division 3, Chapter 9, Article 10 of the Business and Professions Code ("California Business and Professions Code," 2019). It empowers contractors to secure the value of their labor and materials, used to improve real property, by filing a mechanics' lien against the improved property. In the event of default, the contractor's mechanics' lien can be foreclosed to force sale of the property to recover the default ("California Business and Professions Code," 2019, Division 3, Chapter 9, Article 10).

In the case of off-site construction, the entire structure is constructed in a factory where it is not attached to the land. This

distinction is critical to the applicability of mechanics' liens as a mechanism to protect the contractor/off-site manufacturer. Mechanics' liens only protect labor and materials that have been used to improve land, i.e., attached to the Earth and become real property; so, structures that have not been transported to the site and attached to the Earth cannot be protected by mechanics' lien.

Once structures that have been manufactured off-site are transported to the jobsite and attached to the Earth, they become real property and are treated like in situ land improvement.

1.4. Summary of Regulatory Environment

The policy environment related to construction is based on the assumption that real estate development is the product of in situ construction; from the questions on the contractors' license exam to the entitlements and approval process. For instance, the *Law* portion of the California building contracts exam features questions about daily (truck) tailgate meetings and OSHA rules for outdoor construction like safe ladder slopes and harnessing rules, but nothing about factory safety. Skilled tradespersons are segregated under the employment of sub-contractors that perform specific trades as part of a comprehensive construction project. Entitlement/enforcement agencies operate a mobile site inspection operation tasked with visiting construction jobsites where in situ construction occurs. Even the legal framework that protects builders assumes that construction is a progressive process by which a building is methodically erected in place; thus, mechanics liens protect a contractor's investment of labor and materials only as part of such a process.

Myriad studies exist researching the potential benefits of off-site construction, documenting the many benefits (Arashpour, Wakefield, Abbasi, Arashpour, & Hosseini, 2018, p. 47; Arashpour, Wakefield, Bliskas, & Minas, 2015, p. 72; Bliskas, Pasquire, & Gibb, 2006, p. 122; Boyd, Khalfan, & Maqsood, 2013, p. 51; Gann, 1996, p. 439; Lawson, Ogden, & Bergin, 2012, p. 148; Thuesen & Hvam, 2013, p. 284); or in response to the aforementioned discoveries, working to better understand the reasons why adoption is low, despite their well-documented benefits (Arif, Goulding, & Rahimian, 2012, p. 77; Goodier, 2005, p. 153; Mao et al., 2016, p. 221; Rahman, 2014, p. 75; Xue, Zhang, Su, Wu, & Yang, 2018, p. 490).

Despite the litany of academic literature lauding the various benefits of OSC, and the strong, well-documented recommendations from the Big-5 global consulting firms, encouraging adoption of OSC, the in situ method remains the industry standard, and off-site development projects are still uncommon in the Los Angeles Metro region. One possible explanation for poor uptake is exploitation of market power by incumbent landlords. Traditional in situ construction is inefficient, and plagued with labor shortages, and other issues. “Traditional ways of managing construction projects are inflexible and fragmented as each process is assigned to a trade contractor with an individual specialization, and trades with the greatest work content (bottlenecks) limit the progress rate of projects” (Arashpour, Wakefield, Bliskas, & Minas, 2015, p. 73). These shortcomings or even policy positions that are unfavorable to OSC can be strategically advantageous to an incumbent landlord which has defeated those hurdles. They can be effective barriers to unwanted competition. If such a paradigm exists and can be

identified, it could explain why promising advances in construction technology have scarcely been employed to address one of the most salient current societal challenges.

This study contributes to the body of knowledge regarding the obstacles to the adoption of OSC by examining the motives of the decisionmakers that set housing production levels and can either exploit OSC to boost production or act as a bottleneck that impedes OSC housing production in the Los Angeles Metro area. These motives are important because they serve as an indicator of the disposition of the market; either competitive or in market failure. Producers in a failing market are faced with different incentives than those in a competitive market so uncovering the incentives and motives that shape their market strategies provides valuable insights into the market itself. Further, understanding these motives is instrumental to the search for a viable framework through which to model decisions related to the adoption of OSC in the production of multifamily housing.

The stage was set for this study by growing interest from both the academic and business communities; whose findings suggest that OSC could be a powerful factor to help address housing challenges which policymakers have thus far been unable to solve.

1.5. Early Examples of Off-site Construction

Off-site production (OSP), a.k.a., off-site construction (OSC) or off-site manufacturing (OSM) is not a recent innovation. “OSP is not new, and arguably dates back to the twelfth century (Gibb, 1999)” (Nadim & Goulding, 2011, p. 83). The precise genesis of it in the U.S. is unknown, presumably sometime in the late 19th Century; but perhaps the most ambitious government policy encouraging off-site construction began in 1969, when George W. Romney, Secretary of Housing and Urban Development,

launched “Operation Breakthrough,” an initiative intended to industrialize housing production in the U.S (Ford, 1972, p. 1). “Secretary Romney, who was once the president of American Motors, believed that the cost of housing could be substantially reduced if more construction took place in the factory, rather than onsite, and if modular construction techniques were more widely used. Operation Breakthrough made this vision a reality. Begun in 1969, Operation Breakthrough fostered the assembling of mass-produced, factory-built housing that employed the latest developments in housing technology” (Foote, Embry, & Shalala, 1995, p. 75). But Romney’s tenure as HUD Secretary was short-lived. His *Open Communities* program to pressure local governments to change exclusionary zoning laws resulted in his ouster in January 1973 (Rothstein, 2017, p. 201). Operation Breakthrough did not revolutionize American housing production, as Romney envisioned, but it did provide lessons vis-à-vis nine proof-of-concept sites across the U.S., including the only California site, located in Sacramento (Ford, 1972, p. 35).

Off-site modular construction (OSC) is a *modern method of construction* (MMC), not a type of structure. After the construction phase, a building could have either been constructed by assembling components produced in a factory off-site, or it could have been erected as a stick-built building, constructed in the traditional *situ* fashion, with no material difference between the two. This point of fact is an important distinction because it dispels the myth that off-site construction produces substandard buildings or even limits aesthetic or functional requirements—it doesn’t.

1.6. Global Interest in Off-site Construction

“Recent calls were launched worldwide for the “revival” of offsite production (OSP) (under numerous nomenclatures [also OSM or OSC; off-site manufacturing or construction, respectively]) in order to improve the construction industry, meet market demand; and furthermore, overcome the dependence on skilled labour” (Nadim & Goulding, 2011, p. 82). The call has been answered in various places around the globe including Malaysia, Hong Kong, China, and Sweden (Jin, Gao, Cheshmehzangi, & Aboagye-Nimo, 2018, p. 1208). “A survey conducted by Inside Housing magazine in March 2014, showed that over the three successive years, 56.8% of 22,544 homes planned by 17 of the UK’s largest housing associations will be constructed using offsite methods” (Threlfall, 2016, p. 6). In 2001 Hong Kong began promoting prefabrication through its Building Department’s Joint Practice Notes 1 and 2 (Jaillon & Poon, 2010, p. 1027). Australia’s national Construction 2020 initiative established eight aspirational visions for the nation’s construction industry by 2020. “In Vision Seven, a majority of construction products will be manufactured in factories off-site and brought to the site for assembly” (Hampson & Brandon, 2004, p. 24).

2. Literature Review

2.1. Academic Studies

Academic exploration of off-site construction (OSC) is rife with research into its benefits. The data overwhelmingly demonstrates off-site construction's great potential to produce a higher quality product, shorter lead times, and lower total cost (Arashpour, Wakefield, et al., 2018, p. 47; Arashpour, Wakefield, Blismas, & Minas, 2015, p. 72; Blismas et al., 2006, p. 122; Boyd et al., 2013, p. 51; Gann, 1996, p. 439; Lawson et al., 2012, p. 148; Thuesen & Hvam, 2013, p. 284). Earlier literature, including Gann's study comparing automobile manufacturing and housing production in Japan, tend to prove out the virtues of off-site, industrialized housing production (Gann, 1996). Later studies, e.g., *Barriers of Implementing Modern Methods of Construction (2014)*, assume the reader is already familiar with the academic community's endorsement of the potential benefits of off-site methods, and focus on investigating the impediments to widespread adoption. "The adoption of MMCs is low, despite their well-documented benefits. This led to the present study of examining the importance of common barriers to implementing MMCs" (Rahman, 2014, p. 75). Some scholars explore potential exploitations of the increased efficiencies afforded by the application of manufacturing operations to the construction industry. "One of the strategies for escaping the red ocean market has been to develop off-site manufacturing (OSM) practices, a development that has been discussed and supported through initiatives such as Manubuild (Eichert and Kazi 2007; Kazi et al. 2009) and reflected upon in Arif (2009)" (Thuesen & Hvam, 2013, p. 279). *Application of Modular Construction in High-Rise Buildings* typifies the angle of approach from the architectural discipline, by means of case studies of three

modular high-rise apartments (Lawson et al., 2012). The research revealed a reduction in solid waste, less traffic and noise, lower risk of worker injury, and improved airtightness and sound insulation. The study also “shows that modular construction can be used for residential buildings up to 25 stories high, provided the stability is achieved by a concrete or steel framed core” (Lawson et al., 2012, p. 153) .

Studies are conducted in many locations around the globe, including Hong Kong, Australia, Canada, India, Singapore, United Kingdom, Netherlands, and others. Conspicuously missing from the conversation is research related to OSC in Los Angeles, the epicenter of California’s, if not America’s, housing crisis. Prolific off-site researchers e.g., Blismas and Arashpour have become sophisticated in their inquiry, moving beyond simply investigating the merits of off-site construction and now peering into the more granular aspects of industrialized efficiency. The following excerpt from the abstract of *Autonomous production tracking for augmenting output in off-site construction* exposes the level of sophistication associated with the international conversation:

Problems in existing methods of production tracking in off-site construction result in schedule delays and increased costs. To eliminate these deficiencies, an autonomous production tracking that analyzes real-time production data is proposed. A specific implementation of the proposed production tracking mechanisms has been developed for a large off-site construction plant in Australia, and is in the process of installation. (Arashpour, Wakefield, Blismas, & Maqsood, 2015, p. 13)

While studies in Europe, Asia, and Australia (Arashpour et al., 2017; Boyd et al., 2013; Gann, 1996; Goodier, 2005; Maas & van Eekelen, 2004; Rahman, 2014; Thuesen & Hvam, 2013; Xue et al., 2018) finetune industrial processes and identify best practice, the Los Angeles conversation tends to be directed to less technical concerns i.e., labor law litigation as discussed by construction attorney, Bruce Rudman in his *Reeves Journal* article (Rudman, 2015).

The U.S. is not totally without scholarship in the field of OSC. Leading the more progressive conversation about OSC in the U.S. are Ivan Rupnik, in Boston, and Ryan Smith from the University of Utah who has written several seminal books on the subject:

Prefab Architecture: A Guide to Modular Design and Construction

Building Systems: Design Technology and Society

Permanent Modular Structures: Process, Practice, Performance

Building Systems: Design Technology and Society

Smith is an important voice in the U.S. off-site/modular community; his inquiry and authorship educate the how-to aspects of the craft. He doesn't discuss practical politics as Rudman does (Rudman, 2015); he hasn't focused to the level of technical minutia that Arashpour, Wakefield, Blismas, & Maqsood do (Arashpour et al., 2017; Arashpour, Wakefield, et al., 2018; Arashpour, Wakefield, Blismas, & Maqsood, 2015; Arashpour, Wakefield, Blismas, & Minas, 2015). Neither does he explore the regulatory challenges nor public and private policy environments.

Ivan Rupnik taught Architecture at Harvard before joining the faculty at Northeastern University. He conducts important research through his graduate research lab and shares the work product through industry workshops and site visits which he co-

hosts with the Modular Building Institute several times throughout the year and advises HUD and the National Renewal Energy Lab.

The frequency and depth of focused scholarship related to OSC varies from one part of the world to another. Some of this variation could be related to the inavailability of suitable research subjects; and some could be related to the relative perceived urgency of the need for modern solutions in the area of housing production. Los Angeles does not present many opportunities to study local manufacturers and highly visible elements of the housing crisis, e.g., homeless encampments, can eclipse subtle motivations that may impede the adoption of unconventional solutions. The depth of the housing crisis, characterized by shortages, high cost, and even economic homelessness, cries out for research that investigates practical, immediate solutions.

2.2. Big Consulting

International consulting firms take a global perspective—McKinsey, in a 2017 report entitled *Reinventing Construction: A Route to Higher Productivity*, evaluates the construction industry through a consultant’s lens. In a chapter titled, *A Production System Could Boost Productivity Tenfold*, McKinsey asserts, “[...]a transformative five-to tenfold increase in productivity would be possible if construction were to move to a manufacturing-like system of mass production with a much greater degree of standardization and modularization and the bulk of construction work taking place in factories off-site” (Bughin et al., 2017, p. 115).

The 168-page report is focused on increasing productivity in the construction sector. It compares exponential productivity advances in other industries with productivity losses in the construction industry. “In the United States since 1945,

productivity in manufacturing, retail, and agriculture has grown by as much as 1,500 percent; productivity in construction has barely increased at all. This not only represents a lost opportunity for the industry but costs the world economy” (Bughin et al., 2017, p. vi).

Ernst & Young prescribes a wholistic solution to industrializing construction that includes, digitization, building information modeling (BIM), and Lean manufacturing, applied to OSC. They say,

Off-site construction materially impacts each of the key performance indicators of construction: productivity, quality, safety, time and budget.

- The quality, productivity and safety that can be achieved in an automated, controlled environment are likely to exceed those possible on-site.
- Any “critical path” construction activity that can be moved to “offsite construction” enables a reduction in overall construction time. This ranges from using pre-cast concrete to reduce curing times to installing completed modules (*EY - Construction sector transformation: The productivity drivers*, 2018).

“The EY report also features several powerful quotes from industry voices:

The true current day value of prefabrication is its ability to ‘crunch the schedule’ and deliver projects with greater speed and populate the building with paying tenants.”

— Stacy Scopano, *Innovation, Development & Construction, Skanska USA*)

“As an analogy, the automotive industry used to build cars onsite and suppliers provided spark plugs and cables. Today, cars are assembled, and suppliers

provide the entire ignition system. Automobile manufacture has moved from construction from parts to assembly of components. The change needed in construction is a move from delivering concrete and materials to delivering walls, floors, rooms for on-site assembly.”

— Christian Birck, *Head of Customer Excellence & Innovation, LafargeHolcim*”
(*EY - Construction sector transformation: The productivity drivers*, 2018).

It should be noted that EY’s report is more of a description of observable trends and realities, not a guidance document suggesting change. They have observed change and predict that it will accelerate. “Like BIM and Lean, off-site construction — encompassing prefabrication (prefab) and modular construction (modular) — has been around for decades but is reentering the spotlight as a viable means to addressing the central issues: time, budget, productivity, quality and safety” (*EY - Construction sector transformation: The productivity drivers*, 2018). “For example, a contractor could prefabricate complete kitchen pods in an off-site assembly line and then ship them to the site once the building structure is ready. This ‘plug and play’ approach saves enormous construction time and costs compared to the traditional method of fabricating everything on site” (Borgogna, Majdalani, & Bejjani, 2015, p. 13)

“Homeownership rates among young adults today are even lower than in 1988, and the share of cost-burdened renters is significantly higher. Soaring housing costs are largely to blame, with the national median rent rising 20 percent faster than overall inflation in 1990 - 2016 and the median home price 41 percent faster” (*The State of the Nation's Housing 2018*, 2018, p. 1). Industry standard development practices are unlikely to address the current housing crisis in Los Angeles, but wider adoption of

practices with well documented benefits show promise. Global management consulting giant, McKinsey & Company recommends, "mass production, standardization, prefabrication, and modularization—a production system—that has the potential to boost productivity by five to ten times, depending on the sector" (Bughin et al., 2017).

Researching the public and private policy surrounding off-site construction promises to inject a missing dimension to the understanding of the local development culture related to one of the most promising advancements in building technology available to address LA's housing crisis.

Deloitte highlights catastrophic vulnerabilities in the standard, in situ, construction ecosystem; "Labor shortages are reaching crisis proportions and are expected to continue through 2019 as well. The impact of not filling job openings and not having the right skill set in the workforce can negatively impact engineering and construction companies in various ways, including not being able to respond to market needs, losing project bids, and failing to innovate" (Meisels, 2019, p. 6). Deloitte praises the superiority of off-site construction (referred to as *unitized building process*), "A state-of-the-art unitized building process is cheaper, faster, and safer than a conventional building process, while the resulting buildings are indistinguishable from those built via a conventional process. The approach is cheaper and faster because there is less waste during construction" (Evans-Greenwood, Hillard, & Williams, 2019, p. 6).

KPMG is also focused on the underperformance of traditional construction methods, resulting from low productivity, low certainty in delivery, skills shortage, and data transparency issues; and, has identified OSC as the cure. "Offsite construction - the prefabrication, modularisation and standardisation of construction processes and assets

within controlled factory environments - continues to be quoted across government and industry as a potential catalyst in meeting these challenges.” Some sharp contrasts paint a clear picture of OSC’s value. “In 2015, design and construction phases of UK construction projects were delivered either on time or better only 53% and 48% of the time respectively—meaning that almost 50% of all onsite construction projects failed to predict reliably their programme completion dates. Evidence from Buildoffsite suggests that schedule savings of up to 60% are possible when compared against conventional construction” (Threlfall, 2016).

2.3. Consensus Opinion

There appears to be nearly unanimous consensus that OSC is potentially a faster, more precise, less wasteful, and more efficient way to build. Most studies—not all—find that the method produces significant cost saving, while increased safety, reduced environmental impact, and other benefits are universally accepted as expected benefits. Saving time is another universally accepted benefit and may be the most important of them all with regard to improving the financial viability of off-site construction to developers.

The issue of off-site cost savings is disputed among studies—if that datapoint is conflated with financial benefit, the financial benefits of time saving are lost to the analysis. One area of research that has been neglected is a more wholistic cost-benefit analysis that accounts for not only hard costs, e.g., labor, materials, transportation, etc., but also incorporates a time-value-of money feasibility analysis. Real estate developers choose to accept or reject projects based on a *pro forma* analysis of projected cashflows; “the ability to modify and develop pro forma cash flow statements and to undertake a

competitive market analysis serve as foundations for analysis and for estimating an investment value for properties” (Brueggeman & Fisher, 2011, p. 290).

A comprehensive pro forma analysis is based on calculating the present value of future cashflows. “The discounted present value method, the final income capitalization technique, is based on the principle that investors will pay no more for a property than the present value of all future NOIs” (Brueggeman & Fisher, 2011, p. 306).

The equation used to discount the current value of future real estate cash flows, to determine what they are worth today, is the *present value formula*: $PV = \frac{FV}{(1+i)^n}$ where FV is the future value of a cashflow, i is the discount rate (or the estimated annual return of the opportunity cost), n is the number of years into the future a cashflow will occur, and PV is the value of FV as discounted back n years to the present time (year 0). The variable n is an exponent with literal exponential impact on the denominator of the present value formula, so small n (closer to the present) equates to comparatively large PV as compared to larger n (farther into the future). To calculate the present value of a series of future cashflows, as would be done to establish the value of housing in terms of its annual net operating income (NOI), each cashflow, i.e., each year’s net profit or loss is discounted back to year 0 and summed. This operation is applied to both positive and negative cashflows—for instance, the purchase of land and construction of land improvement would produce a negative cashflow (money flowing out).

Keeping in mind that the first few years of a discounted cash flow proforma have the greatest weight in present value, the time savings of any method of construction has a magnified impact on value, based solely on the fact that it occurs beginning in year

zero. Accounting for changes in the value of real estate investment tied to cashflows over time is associated with the financial principle referred to as *time value of money* (TVM).

2.4. Theoretical Framework

2.4.1. Market Dynamics

The *supply and demand* graph (Figure 3) helps us to understand market behavior by plotting the quantities that producers will produce and consumers will consume at various market prices. The intersection of the two curves at *E* is the theoretical point at which a

market has reached equilibrium, i.e., *supply* and *demand* are balanced (Marshall, 1890, p. 288). The *supply* and *demand* curves illustrate the relationship between the financial motivations of suppliers and consumers to produce and consume, respectively, a given product at any given price. To understand how producers choose and set desired production levels in a competitive market, this simple diagram can provide insights.

To correctly understand the benefit to a producer of housing, production benefit is not evaluated as revenue minus cost-of-goods-sold, like a consumer good, but rather as a wholistic value that evaluates a housing development as an investment asset class or capital good, in terms of its *internal rate of return* (IRR); a ratio that accounts for the initial investment, an outbound cashflow, against future inbound cashflows, using *time value of money* cashflow analysis. This element of the

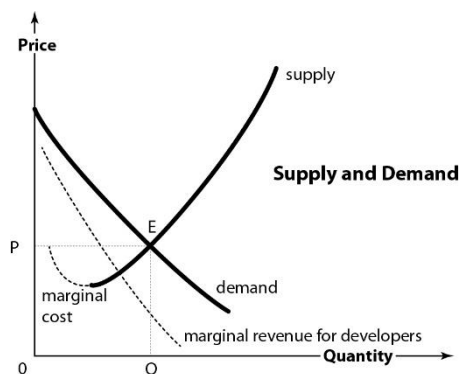


Figure 3

analysis is particularly germane to the discussion of off-site construction because speed of production has been universally recognized as a consistent and important benefit. Housing production (*supply*) is a function of investment in real estate development as an asset class which yields cashflow returns over time.

The consensus viewpoint of *big-consulting* (Borgogna et al., 2015; Bughin et al., 2017; Evans-Greenwood et al., 2019; *EY - Construction sector transformation: The productivity drivers*, 2018; Threlfall, 2016) and the academic literature (Arif et al., 2012; Jaillon & Poon, 2008; Jin et al., 2018; Lou & Kamar, 2012; Nadim & Goulding, 2011; Pan, Gibb, & Dainty, 2012; R. E. Smith & Rice, 2015; Tam, Tam, Zeng, & Ng, 2007; Wu et al., 2019) is that off-site construction promises to be a much faster, more efficient method for producing higher quality housing. *Time value of money* principles suggest that *caeteris paribus*, faster production is predictive of increased profits; producer theory suggests that increased profits should result in increased production at any given price, which could help to ease LA's housing shortage and unaffordability crisis.

Unfortunately, the recommendations of *big-consulting* and the messages from academics on three continents appears not to have been received by American real estate developers. Given the strong support from business consulting leaders and promising findings from numerous published academics studies, adoption of off-site construction would appear to represent an opportunity to increase production and lower production cost resulting from its well-documented benefits. However, adoption is not widespread, and the market is not moving toward equilibrium.

2.4.2. Oligopolistic Market Failure

Traditionally, housing production has been the domain of relatively small, local general building contractors, either under contract by landowners or as a venture to satisfy speculated market demand. Current research, however, suggests that another economic theory

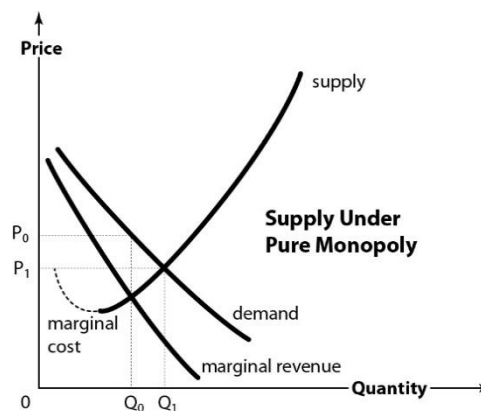


Figure 4

could explain the current housing shortage and simultaneous high price. A study from Johns Hopkins University points to oligopoly theory to explain the current crisis related to housing supply. Cosman and Quintero present data that demonstrate the homebuilding industry's strong trend toward market concentration, so much so that the few large incumbent landlords/producers control enough market share to be classified as oligopolies (Cosman & Quintero, 2018). The study found that, "By 2015 60% of markets surpassed the *highly concentrated* threshold," according to the U.S. Department of Justice and Federal Trade Commission's 2010 guidelines, and "[...]firms in more concentrated markets produce significantly less housing" (Cosman & Quintero, 2018, pp. 3, 15).

The *profit maximization rule*, expressed as $Marginal Cost = Marginal Revenue$, states that suppliers will seek to increase production until marginal cost equals marginal revenue. In the case of a competitive market, the combined production of market producers is depicted as the supply curve in *Figure 3*. When a significant market power is concentrated, as in the case of a monopoly in *Figure 4*,

the sole supplier or colluding cartel of suppliers will seek the profit-maximizing level of production at Q_0 and realize super-normal profits by setting price where Q_0 meets the demand curve at P_0 instead of producing the higher volume market equilibrium level of Q_1 with a corresponding market price P_1 .

When members of an oligopoly collude, i.e. a cartel, their coordinated behavior produces an affect similar to a monopoly market whereby the *profit maximization rule* drives the cartel's production to the quantity at which marginal price is equal to marginal cost, as in *Figure 4*. However, when producers in an oligopoly act in their individual self-interest instead of in the interest of the cohort, the market dynamics dramatically change.

In 1939, Paul Sweezy introduced his theory, featuring a kinked demand curve and a vertical gap in the marginal revenue curve. He postulates that members of an oligopoly are prone to operate independently and in strategic competition with each other. According to Sweezy's theory, when a supplier increases price the elasticity of demand is more elastic than when the supplier reduces price. "From the point of view of any particular producer this means simply that if he raises his price he must expect to lose business to his rivals (his demand curve tends to be elastic going up), while if he cuts his price he has no reason to believe he will succeed in taking business away from his rivals (his demand-curve tends to be inelastic going down)" (Sweezy, 1939, p. 569).

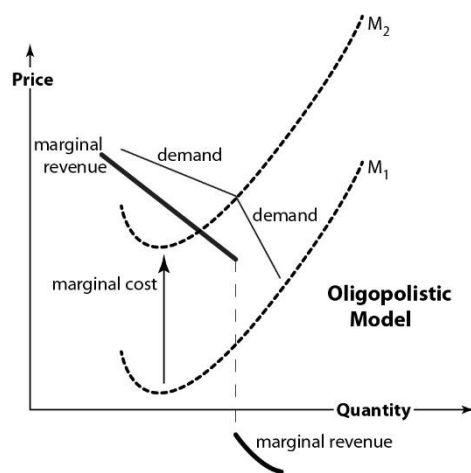


Figure 5

This theory would suggest that an individual supplier would resist raising price when the marginal cost curve passes through the gap in the marginal revenue curve as shown by M_1 in *Figure 5*, and this price stability is a prediction of Sweezy's model; this does not appear to be a characteristic of the LA housing market (Woo, 2016).

If Sweezy's model is an accurate depiction of the market, upward price mobility would indicate that the marginal cost is now intersecting with marginal revenue as shown by M_2 in *Figure 5*, e.g., production cost is high, although the dominant driver of production levels is oligopolistic competition not competitive market dynamics. Another possible explanation for price volatility is a shrinking cohort—as market power becomes more concentrated, the market dynamics become more monopolistic.

Sweezy's model attributes low housing production to the exploitation of oligopolistic market power in the pursuit of profit-maximization, which would be consistent with a housing supplier being resistant to improved construction methods likely to erode barriers to production competition, i.e., off-site modular construction. However, the applicability of this theory is far from certain. Oligopoly requires each producer to control a significant share of the total market. The top 10 apartment owners in Los Angeles County own a combined 58,278 units, just 3.27% of the 1,782,834 renter-occupied dwelling units in the county (Demeter, 2017; "U.S. Census," 2017, 2013-2017 American Community Survey 5-Year Estimates, table DP04).

2.4.3. Complexity of Defining the Supplier and the Market

Cosman and Quinterro explain the shortage of housing in U.S. cities through the lens of oligopoly as a theoretical framework. This explanation assumes market failure, and attributes production shortfalls to oligopolistic market power, employed by producers to sustain super-normal profits. An oligopolist is financially incentivized to constrain production. A rational supplier with oligopolistic market power might be likely to publicly support changes that reduce production cost, and other frictions, but privately act in ways contrary to those claims.

Comparing producers' open assessment of the market against their strategic actions helps to recognize their participation in the market as either an oligopolist or a competitive market supplier. This study provides additional transparency to the mystery of low OSC adoption by investigating the motives of the most prolific incumbent multifamily housing suppliers in Los Angeles.

In the course of investigation, semi-structured interviews and questionnaires were used to query the LA's top landlords by market share.

Unlike a factory that unilaterally sets its own production levels, real estate development, including housing production, is undertaken through a multilateral, successive decision-making chain: a developer initiates, then private equity invests, a lender provides debt financing, and an entitlement agency issues permits, all in response to the VoC (voice of the customer) which represents the needs of buyers and renters. In some cases, one decisionmaker can assume more than one role, e.g., a developer may finance the entire project with its own capital, collapsing the developer, private equity, and lender decisions under one decisionmaker; but, even in

this example, a savvy developer will apply the same evaluation scrutiny as would be applied by experienced investors and lenders. Every link in the chain acts as an escalation gate so a project that is unable to secure approval at one gate will not continue to move forward. In a sense, the entire approval escalation chain is the *producer* for the purposes of deciding production volume.

Stakeholders in the chain are motivated by differing factors, e.g., developers and private equity investors are motivated most by high profit margins, and lenders are motivated most by low risk and volume of market debt, while entitlement agencies are motivated by public interest in housing availability, affordability, and conformity; as a result, they participate in shared production decisions, although not collaboratively, due to understandably conflicting goals.

The decision-making process that sets production levels is multilateral and sophisticated, but the inquiry of this study is focused on determining if the motives of the profit-driven links in the decision-making chain, e.g., most prolific incumbent landlords, are more consistent with market competition or price-making oligopoly power. The research looked for indications that landlords are resistant to increasing the market supply of shelter for rent, i.e., resistant to increasing the production of multifamily housing. This would be a strong indication that they are responding to oligopolistic incentives that encourage building barriers to production, restricting supply to a profit-maximizing level rather than allowing the market to find its natural level of equilibrium.

Defining the market can be nearly as complex as defining the supplier.

Important Census data, including rental vacancy, is segmented by Metropolitan

Statistical Area (MSA) which can include very large and diverse areas; for instance, the MSA which includes Los Angeles also includes Long Beach and Anaheim. The population of the City of Los Angeles alone is 3.8 million, roughly the same as Connecticut or Oklahoma, or more than the populations of North Dakota, South Dakota, Vermont, Wyoming, and Washington DC, combined. Cosman and Quintero chose to delineate by *Census Designated Places* as markets (Cosman & Quintero, 2018, p. 7), which segments Los Angeles County into 52 distinct *Places*.

“Places are a suitable scale for housing markets as they approximately match the spatial range over which consumers search for new housing” (Cosman & Quintero, 2018, p. 7) but scale aside, they don’t necessarily match the markets as segmented by renters. For instance, Koreatown, a.k.a. “K-Town,” is a clear market identifier that’s commonly used by real estate brokers in the promotion of for sale and rental property. LA-based, Jamison Properties is one of the top-10 apartment owners in LA—“the company owns 20 properties in the metro, 19 of which are located within Koreatown, Mid Wilshire East, Mid Wilshire West and Park La Brea North submarkets” (Demeter, 2017), but none of those submarkets are considered *Census Designated Places*.

Real estate markets are also segmented in other ways besides location. GH Palmer Associates is a top-5 Los Angeles apartment owner, “Owning more than 6,000 units in the L.A. area, of which 4,400 are luxury” (Demeter, 2017). They specialize in the luxury category but their most expensive rents (~\$4000/month) are at The Lorenzo, their 913 unit student housing complex near the University of Southern California (Demeter, 2017). This property is a good case study for how many ways

the real estate market can be segmented. The Lorenzo could be segmented along at least three different axes with disputable segment identification in some: by *geography* as being either downtown, in South LA, or near USC; it can be classified in the luxury *category*, or possibly in the (quasi-institutional) off-campus student housing category; and it was built in 2014 so, evaluated by class, The Lorenzo would be considered *Class A* (among classes A, B, C, D).

Defining the market and the supplier are incredibly complex especially when the suppliers and consumers don't necessarily agree with each other or often even agree within their own cohorts. This reality frustrates the modeling of market dynamics, making Cosman and Quintero's theory difficult to validate without verifying the motives and perspectives of market suppliers.

3. Methodology

3.1. Identifying the Gap

“Today, in many regions in the United States, the production of housing - especially infill multifamily housing – has become so costly to produce it demands rents or sale prices that are unaffordable for most people. While the costs of construction is not the only reason housing prices continue to increase, they are certainly a major factor” (Galante & Draper-Zivetz, 2017). Market forces continue to drive up the cost of housing to consumers, according to a 2018 Freddie Mac report on multifamily housing, “vacancy rates came in lower than forecasted and rents increased more than expected” (*FreddieMac Multifamily 2019 Outlook*, 2019, p. 1). Rents are increasing at a rate that’s more than 1½ times as fast as wage growth which averaged 2.8 percent in 2018 (“Bureau of Labor Statistics,” 2019) and CPI inflation, “Prices in the Los Angeles area, as measured by the Consumer Price Index for All Urban Consumers (CPI-U), edged up 0.1 percent in February [...] Over the last 12 months, the CPI-U increased 2.5 percent” (“Bureau of Labor Statistics,” 2019). “REIS shows preliminary asking rent growth of 4.5 percent annually as of the second quarter, down from the annual high of 6.1 percent in 2015” (*FreddieMac Multifamily 2019 Outlook*, 2019, p. 3) which means housing affordability continues to worsen.

Exacerbating the problem, the domestic construction industry is experiencing a shortage of skilled labor. “As the construction industry recovers from the recession, there is an increasing concern about severe labor shortages that could impact many projects” (*Skilled Labor Shortage Risk Mitigation*, 2015) which is particularly troubling in an industry with a very long training/onboarding process. “Registered Apprenticeship

programs may take from 1-6 years to complete, depending on the occupation. Most programs are 3-4 years in length. The length of training (term) is determined by standards adopted by the industry. [and in addition to the apprenticeship] Apprentices must attend Related Technical Instruction which is combined with on-the-job-learning experience. Most programs require approximately 144 hours of Related Technical Instruction per year” (“CA Carpenter Apprenticeship FAQs,” 2019)

The Big-5 consulting firms diagnose a severely outdated housing production process and prescribe off-site construction as the cure (Borgogna et al., 2015; Bughin et al., 2017; *EY - Construction sector transformation: The productivity drivers*, 2018; Meisels, 2019; Threlfall, 2016)

The academic world agrees with the Big-5. Studies of off-site construction on the three continents where it’s most widely used, Asia, Europe, and Australia (and some in Canada as well), present their own independent findings that support off-site construction as a method that’s faster, greener, and produces housing of higher quality (Jaillon & Poon, 2008, p. 953; Jin et al., 2018; Lawson et al., 2012, p. 148; Lou & Kamar, 2012, p. 69; Nadim & Goulding, 2011, p. 83; Pan & Goodier, 2012, p. 91; Rahman, 2014, p. 75; Sadafi, Zain, & Jamil, 2012, p. 142; R. E. Smith & Rice, 2015; Tam et al., 2007, p. 3653; Thuesen & Hvam, 2013, p. 284; Wood, 2012, p. 196) not to mention that “the key effect of using lean construction methods for the purpose of sustainability positively affects the economic dimension by possibly reducing upfront costs, operating costs, and resource savings, and improving performance capability” (Nahmens & Ikuma, 2012, p. 157).

3.2. Research Question Within the Gap

With such strong support for off-site construction from both the business world—vis-à-vis unanimous recommendation of the Big-5—and the academic literature, the unavoidable question is, ‘why isn’t off-site construction being used as a common method of housing production in Los Angeles Metro?’

‘Why?’ is a very big question in terms of academic inquiry—certainly too big a question for this study. First a foundation must be laid. Cosman and Quintero’s study from Johns Hopkins offers a plausible explanation for what might motivate a housing supplier to reject improvements to the construction process (Cosman & Quintero, 2018). among which, off-site construction would be classified by consensus opinion (Bertram, Mischke, & Sjödin, 2019; Borgogna et al., 2015; Bughin et al., 2017; *EY - Construction sector transformation: The productivity drivers*, 2018; Threlfall, 2016). Their nationwide study does not distinguish between the production of single-family and multifamily units.

This study tests oligopoly as a viable theoretical framework which explains the inadequate production volume of multifamily housing in the Los Angeles Metro region. Our hypothesis is that oligopoly is not a viable theoretical framework to explain the inadequate housing production of which has resulted in the regional shortage of housing and shelter.

This research accepts the following assumptions; oligopolists:

1. Resist increasing inventory levels in the market.
2. Prefer to buy from existing inventory over building additional housing stock.

3. Avoid construction technology that increases production volume, e.g., OSC.
4. Are unlikely to characterize the market as a favorable environment for multifamily housing development.

These assumptions being true, if the most prolific incumbent multifamily landlords exhibit the behaviors stipulated in the previous four assumptions, those behaviors would be consistent with an oligopolistic market. But, if they do not exhibit the behaviors stipulated in the previous four assumptions, their practices would not be consistent with an oligopolistic market.

To test the hypothesis, a 67% (two-thirds) sample of the top-6 most prolific incumbent multifamily landlords were directly asked about their business practices related to the four assumptions.

This study asks the primary question:

1. In the Los Angeles Metro region, is oligopoly a viable theoretical framework which explains the inadequate production volume of new multifamily housing as shelter?

Secondary question asks:

2. Are incumbent landlords receptive to off-site construction, which could increase multifamily housing production volume?

3.3. Research Methods

3.3.1. Qualitative — Phenomenology

This research investigates the motives that influence multifamily housing production levels, especially motives that support or disqualify either a competitive market or oligopolistic market failure.

Though some quantitative measures are discussed in this study, they serve to add context to a broader understanding, not to make inference about a larger population. The study is qualitative in nature, employing qualitative methodology as a window into complex executive decisions that impact a pressing social problem. “Qualitative research is an approach for exploring and understanding the meaning individuals or groups ascribe to a social or human problem” (Creswell, 2014, p. 4). “All qualitative research seeks understanding of data that are complex and can be approached only in context” (Morse & Richards, 2013, p. 49).

The case study approach is a good fit for this investigation. “Although much of what we know about the empirical world is drawn from case studies and case studies continue to constitute a large proportion of work generated by the discipline, the case study method is held in low regard or is simply ignored” (Gerring, 2004, p. 341). But this method is a valuable tool for exploring complex themes and discussing them in a narrative fashion. “Case study research can include both single- and multiple-case studies” (Yin, 1989, p. 14), and though this research is envisioned as a single case, “Within-case sampling is almost always nested—for example, studying children within classrooms within schools within neighborhoods, with regular movement up and down that ladder” (Miles, 2014). Also, “Population, unit, case, and observation are nested within each other” (Gerring, 2004, p. 342). “Following is a set of nested definitions, which should be read carefully. A ‘population’ is comprised of a ‘sample’

(studied cases), as well as unstudied cases. A sample is comprised of several ‘units,’ and each unit is observed at discrete points in time, comprising ‘cases.’ A case is comprised of several relevant dimensions (‘variables’), each of which is built upon an ‘observation’ or observations” (Gerring, 2004, p. 342).

Semi-structured interviews and written questions serve as effective channels of inquiry—subject responses provide first-hand access to the mindset of two-thirds of the total population of the study group. The research is designed as semi-structured and unstructured interviews where, “relatively few prepared questions are asked; there may be only one or more grand tour questions. The researcher listens to and learns from the participant. Unplanned, unanticipated questions may be used, along with probes for clarification” (Morse & Richards, 2013, p. 124).

Some subjects are reluctant to participate in a live interview format but are comfortable with the same questions presented in written form whereas their responses can be carefully worded and tightly controlled prior to submission. This method is a particularly good fit for this type of research. In this case study, “Data from a small number of cases selected to inform a particular issue or problem are thoroughly described. Coding and summarizing data are focused by prior questions of theory to inform detailed understanding and comparison by contextual analysis of factors, events, or condition of interest” (Morse & Richards, 2013, p. 33).

Affective methods coding is used to capture emotion, perspective, and intra-industry conflicts. *Process coding* is also applied to identify the progression of development activity as context for *emotion*, *value*, and *versus* coding (Hakimdavar, 2018).

3.3.1.1. Selection of Subjects

For any type of real estate development to occur, members of four primary stakeholder groups must be willing to participate. Those groups are: real estate developers/owners, private equity, mortgage lenders, and entitlements agencies. They fall into three categories: those who initiate projects, those who finance projects, and those who approve projects. The group that initiates projects primarily comprises real estate developers; the group that finances projects comprises private equity investors and mortgage lenders; the category that approves projects comprises the municipalities that grant entitlements.

Though all three groups participate in go/no-go decisions related to the production of housing, this study focuses on the most prolific owners of multifamily housing. Developers are often the owners of the housing projects they develop, but they sometimes also build and sell to new ownership. Oligopolistic incentives would mostly be associated with incumbent landlords, as theorized by Cosman and Quintero, so data was gathered directly from those landlords' corporate executives, responsible for production decisions in the Los Angeles Metro area. No differentiation was made in the selection process between landlords that build and those who purchase; though, the preferred practice of each is captured as a data point.

3.3.1.2. Data Collection

Subjects

This study investigates the motives that influence go/no-go production decisions by the incumbent landlords with the most market power in the Los Angeles Metro area; so, the six most prolific landlord companies are determined to define the full population, and within each of these companies, the executive responsible for making production decisions is selected as the prime subject.

The list of LA's top ten largest incumbent landlords is published by Multi-Housing News, citing data compiled by YARDI® Matrix (Demeter, 2017). The top six companies are: Equity Residential, Essex Property Trust, LA Housing Authority, GH Palmer Associates, AvalonBay Communities, and Goldrich & Kest. The remaining four companies are Jamison Properties, Prime Group, Carmel Partners, and Aimco.

Sixty-seven percent of the population responded to questions in written or interview format. Participants comprise: Los Angeles Housing Authority, AvalonBay, Goldrich & Kest, and GH Palmer Associates.

Data Management

Collateral is catalogued and secured on a password protected drive which will be destroyed upon the successful defense of this dissertation. Presently, only Brent Musson and his research committee have access to the data and the data will only be used in the course of research for this study.

Collected data has been analyzed including *affective coding* to capture emotion, different perspectives, and areas of agreement or disagreement

between participants, and *process coding* to draw connection between the ongoing activities of individual actors.

3.3.1.3. Rationale for Data Collection

This research specifically targets the primary stakeholders who participate in or are directly exposed to decisions about the supply of multifamily housing in Los Angeles. The research questions and style of inquiry are intended to reveal what motivations may be present as they make decisions related to the construction of new multifamily housing, paying particular attention to their disposition related to the adoption or rejection of off-site construction as a strategy for advancing future development.

The value of this research is applicable to multiple disciplines, including urban planning, business, finance, sociology, architecture & design, social work, and many more; but, the disciplines which are most empowered to make informed decisions in practice are business, public policy, and law. The broad use of case studies in law, business, and policy schools, where real estate developers and policymakers are taught, is a compelling rationale for the use of case study methodology to study this public-private policy question, because the completed study can easily be applied to practice through introducing the case study to students who quickly become practitioners in the real estate development industry or policymakers that influence it.

3.3.2. Research Design

3.3.2.1. Selection of Participants & Rationale

The body of literature has established a disconnect between the well-documented benefits of OSC plus the unanimous endorsement of the business thought leaders on one side, and the industry's failure to adopt OSC as a common method on the other; in response, this study explores one aspect of that gap—the unknown motivations that impede the adoption of OSC in multifamily housing development.

Selection of research subjects is guided by the level of their influence on the decision-making process with regard to selecting or rejecting off-site as the construction strategy for multifamily development projects in the Los Angeles Metro region. Prospects with greater market presence and influence on the process are of higher value to the study.

Specific representatives from stakeholder organizations are individually targeted for participation based on their professional influence, within their organization, upon the decision-making process.

The overarching rationale for the selection of particular participants is to recruit those who wield influence over decisions to accept or reject OSC of housing in Los Angeles Metro.

3.3.2.2. Rationality for the Study

LA is suffering from a housing crisis—rents are high and there aren't enough units of housing. One major problem seems to be the cost of building new units. But a recent study suggests that

incumbent landlords benefit from the shortage because a shortage of supply results in super-normal profits for them.

Though studies have surveyed industry professionals for opinion about barriers to the adoption of OSC, the literature has failed to produce a viable theoretical framework through which to understand the phenomenon. This research applies a macro-economic framework that has been used to model the broader phenomenon of low housing production. OSC is a method that has been well-established in the literature as demonstrating superiority in production efficiency. So, a theoretical framework that provides a rationale explaining why producers might underproduce housing, even in a housing shortage, could also explain why those producers would be slow to adopt the superior production method, OSC.

This study queries the decisionmakers that set the production volume of new housing, to uncover what incentives they are responding to. One possible set of incentives is indicative of oligopolistic market failure; another set of incentives is indicative of a competitive market. By understanding the incentives that decisionmakers are responding to, we can better understand the disposition of the market.

3.3.2.3. Fidelity of Subject Responses

Questions asked of subjects are designed to probe incentives and motives, vis-à-vis production volume of new multifamily housing

in the regional marketplace. Revelation of this kind could be somewhat sensitive, so it would not be inconceivable for subjects to be less than forthcoming with responses that could reflect unfavorably on the company's purposeful actions, especially if the consequence of those actions could be construed as further exacerbating the regional housing crisis.

To encourage truthful responses, our inquiry is deconstructed into individually innocuous questions, e.g., Do you primarily buy or build? Is your inventory decreasing, remaining stable, or increasing? Are you interested in increasing your inventory? Each of these questions is binary and neither response reveals any practice that would be considered damaging to the subject, which provides adequate cover for truthful answers, unbiased by concerns related to public perception.

Analysis of subjects' deconstructed responses reconstitutes answers to provide deeper insight into the research question itself. Considering the three innocuous questions about inventory levels and preference to buy or build, particular combinations of answers are indicative of one market approach or the other. A combination of stable unit inventory, expressed interest in increasing inventory, and a preference to buy could be interpreted to portend resistance to increase market inventories, coupled with a desire to portray the market as inhospitable to development. Such a market approach would be

consistent with oligopoly. Increasing inventory, a desire to continue to increase inventory, and a preference to build, could be interpreted to portend willingness to increase market inventories, coupled with open optimism about the market. Such a market approach would be inconsistent with oligopoly.

4. Findings

4.1. Framing the Inquiry

This study investigates the motivations of the six most prolific incumbent multifamily landlords in the Los Angeles Metro region to test for oligopolistic decision-making as related to the production of new units of housing, added to existing inventory.

Oligopolists exert market power to control the level of production in the market in ways that maximize their profits. To understand oligopolistic producers in the real estate market, it's necessary to clarify production and consumption. Specifically, it's important to understand the distinction between a capital good, e.g., real estate and the consumer good produced by it, i.e., shelter. Like all consumer choice models, oligopoly theory predicts the behavior of producers and consumers of consumer goods. Consumer goods are purchased at a given price and provide a finite consumable utility; whereas, capital goods require an initial capital investment and ongoing operational overhead to produce market value in perpetuity. A classic example of a capital good is a factory—the factory may produce clothing, toys, or any of several consumer goods. A taxi is a capital good that produces the service of transportation, while a private automobile is classified as a durable consumer good—ridesharing blurs the lines between the two. The consumer good produced by housing is shelter, a service.

The distinction is particularly relevant to this test because as a variant of consumer choice theory, oligopoly theory is intended to model the expected behavior of a producer of a consumer good; so, this study tests the incentives of our sample relevant to the production of shelter. Shelter is the consumer good derived from the housing that our subjects decide to build or buy.

Having made that distinction, it is no more necessary for a producer of shelter to also be the producer (builder) of housing than it is for the producer of blue jeans to also be the producer of a textile factory. Though producers of shelter often produce/build their own housing inventory, they can also be purchasers of existing housing stock.

Decisions that yield shelter are complex. Shelter is the consumer good that is produced by housing, a capital good. The yield of shelter from housing is calculated by counting one unit of shelter for each unit of housing, multiplied by a given period of time; so, housing production and the production of shelter can easily be conflated. But an important distinction should be considered; the production/building/construction of housing, as a capital good, increases market capacity to produce shelter as a consumer good. Each day that a unit of housing is occupied, a day of shelter is consumed. The production of shelter can be expressed as: $shelter = housing \times time\ period$

4.2. Data Collected as Subject Responses

4.2.1. Disposition

This study tests oligopoly as an appropriate theoretical framework through which to understand the relationship between low adoption of OSC and market incentives in LA Metro. The underlying question for each research subject is, “Are you an oligopolist who intentionally constrains housing inventory to maximize profit?” We have no reason to assume that subjects would avoid being classified as members of an oligopoly; however, they would almost certainly be reluctant to openly discuss the strategic incentives predicted by oligopoly theory (Shapiro, 1989, pp. 333, 349, 400; Sweezy, 1939, p. 569) which

naturally impounds monopoly-like downward pressure on production levels in exchange for super-normal profits for producers.

	LA Housing Dept.	Subject 2	Subject 3	Subject 4
Do you primarily buy or build?	Buy	Build	Build	Buy
Has your company adopted off-site methodology?	No	<u>Yes</u>	<u>Yes</u>	No
Are you interested in increasing your inventory?	<u>Increasing</u>	<u>Increasing</u>	<u>Increasing</u>	Stable
What external forces are most responsible for your current inventory level?	Zoning ("downzoned"), Cost - prevailing wage, materials cost	Low interest rates and relatively low return requirements of the capital partners of competing firms.	Strong under-served demand for housing. / The region's diverse economy. / High barrier to entry markets.	[Subject 4] is a long-term holder of real estate. Any acquisitions of new properties would be funded by the disposition of current properties. We are annually selecting some commercial properties and MF properties for disposition, then generally exchanging into MF properties, in the Los Angeles area and the Austin Texas area.
What do you see as the biggest obstacles to off-site construction in the LA area?	Transportation cost, union challenges, scheduling issues, not wanting to be the guinea pig, and "local hire" challenges.	Off-site construction, or portions thereof, differ depending upon the complexity of the development project. For our purposes, we utilize off-site panel framing. We also do certain pre-assembly of certain plumbing/fixture products prior to delivery to the job site.	COST, schedule and design considerations are the biggest obstacles at the moment.	Not too familiar with it.
Market Rank	Top 4	Top 4	Top 6	Top 6

Figure 6

Instead of asking the underlying question directly, markers of an oligopolistic approach are identified and tracked. The oligopolistic feature most relevant to the housing crisis is the downward pressure on the production volume of shelter. So, markers related to producers' sensitivity to those pressures is tested. Markers that could indicate this type of high sensitivity include preference to buy rather than build, resistance to adopt more efficient off-site construction methods, resistance to growing unit inventories, and expression of pessimism about the market.

4.2.2. Responses

One of the top six most prolific landlords is the Los Angeles Housing Authority, the only research subject that is not a for-profit business. In addition to the 9,375 housing units that the Housing Authority owns, it also provides over 100,000 units of shelter by way of various voucher/subsidy programs.

The Housing Authority is a government agency which does not operate a for-profit enterprise. As such, it is pre-determined not to act as an oligopolist. However, the agency's responses are useful as a baseline for certain known incentives. Except where specified, the following response analysis relates to the for-profit subjects only.

Subjects were asked up to sixteen questions. *Figure 6* contains their responses to the five questions most relevant to oligopolistic behaviors. Other questions not shown in *Figure 6* asked about subject awareness of other developers' practices related to OSC, verified subjects' unit inventories, and other innocuous inquiries.

One datapoint that does not directly address how a subject does, or does not, exhibit any of the four behaviors associated with oligopolists is related to political activism. Subjects were asked, “Is your company politically active?” and if so, “What actions, if any, have you taken in support of policies that remove barriers to development?”

Two-thirds of subjects actively opposed Proposition 10, a California rent control initiative that was defeated November 2018. Proposition 10 would have repealed the Costa-Hawkins Rental Housing Act and allowed local governments to adopt local rent control ordinances and enforce them within the county line or city limits.

4.2.2.1. Buy or Build?

Two-thirds of the subjects build their multifamily housing assets from the ground up. One-third chooses to buy from existing market inventory. The preference to either buy from existing housing inventory or to add to market inventory by building new housing can be indicative of the subjects’ sensitivity to oligopolistic incentives.

4.2.2.2. Adopt Off-site Construction Methods

Two-thirds of the subjects currently use or have recently used OSC methods to produce new multifamily housing. OSC has been lauded by both academic literature and Big-5 consulting as a more efficient, faster, and more cost-effective method of production. The adoption of this method could increase production productivity by five- to ten-fold and accelerate timetables by 20-50% (Bertram, Fuchs, et al., 2019, p. 10;

Bughin et al., 2017, p. 115). Subjects' receptivity or resistance to OSC is relevant to their strategic interest in introducing higher production productivity and accelerated timetables.

4.2.2.3. Inventory Levels

Since the 2017 YARDI® Matrix data was compiled (Demeter, 2017), the unit counts of each of the participants has notably increased. Subjects universally self-reported higher unit counts. The total increase represents approximately a 19.8% inventory expansion. The participants' self-reported unit counts all fall between 9,000 to 13,000. Two-thirds of the research subjects build new inventory, so their inventory expansion adds directly to market production of shelter, while one-third buys existing inventory which has no direct impact on market inventory levels.

4.2.2.4. Bullish or Bearish?

In response to a prompt to identify what external factors are most responsible for their current internal inventory levels, two-thirds of the subjects are very optimistic about external factors, citing strong underserved market demand, diverse regional economy, low interest rates, and availability of capital.

The remaining subject response was neither optimistic nor pessimistic. But the Housing Authority took a decidedly pessimistic tack, citing: high labor and materials costs, and downzoning (the reclassification of land to a zoning designation with a less permissive density designation).

4.3. Environmental Factors

4.3.1. Market Concentration

The key determinant of oligopoly is market concentration. In most U.S. market categories, the top-4 producers supply less than 50% of the market, but there are some glaring examples where the top-4 control 80-90% of the market, e.g., breakfast cereal, aircraft manufacturing, and cigarettes. The percentage of the market produced by those firms is called the *concentration ratio* (Mankiw, 2009, p. 346). “In this study we document the high and rising local market concentration in residential construction and investigate the impact of this concentration on market dynamics” (Cosman & Quintero, 2018, p. 2). Another way to measure market concentration is by calculating the Herfindahl-Hirschman Index (HHI). “The HHI is calculated by squaring the market share of each firm competing in the market and then summing the resulting numbers. For example, for a market consisting of four firms with shares of 30, 30, 20, and 20 percent, the HHI is 2,600 ($900 + 900 + 400 + 400 = 2,600$)” (“Herfindahl-Hirschman Index,” 2018).

The concentration ratio in the Los Angeles Metro multifamily market is under 0.017 (less than 2%). As of the most recent YARDI® data in 2017, the top-4 most prolific multifamily landlords control 30,772 of the 1,782,834 renter-occupied dwelling units in the county (Demeter, 2017; “U.S. Census,” 2017, 2013-2017 American Community Survey 5-Year Estimates, table DP04). The HHI for the Los Angeles Metro market is 3.025, including the top-10 most

prolific incumbent landlords. Both indices indicate very low concentration in the Los Angeles Metro market.

4.3.2. Rational Actor Dilemma

Economic consumer choice theories predict the behavior of rational market actors. A rational actor is a well-informed, basic agent that consciously pursues the alternative with the highest self-interested utility (Monroe & Maher, 1995, p. 2).

Applying consumer choice theory to any market assumes that both the consumer and the producer are rational actors. A rational producer will seek the profit-maximizing level of production where marginal benefit is equal to marginal cost—where less production fails to capture potential sales and more production crosses the threshold into diminishing returns.

Housing production volumes are not set by a single, rational actor making go/no-go, profit-maximizing decisions; instead, decisions to build new housing are effected as a series of related, go/no-go decisions taken by stakeholders that act independently and are motivated by different incentives: 1) real estate developers initiate projects and are most motivated by feasibility; 2) private equity investors provide capital in exchange for an ownership share in projects and are most motivated by high profit margins; 3) lenders provide capital as loan debt and are most motivated by low risk; and, 4) entitlement agencies issue building permits and other entitlement documents and are most motivated by conformity to zoning and other city planning guidelines.

Each of the four stakeholder groups must approve a *go* decision before production occurs and production will not occur if any one of them dissents. It's notable that entitlement agencies are entirely disinterested in marginal cost and marginal benefit; in fact, they often impose requirements that undermine profits as a condition of approval, e.g., street improvement assessments, or affordable housing quotas.

4.4. Summation of Findings

Findings are derived from two primary channels of investigation:

- 1) data collected as subject responses, and
- 2) examination of the contextual environment.

4.4.1. Data Collected as Subject Responses

Query responses reveal aggressive expansion in the production of shelter by all research subjects. Universally, construction of new housing has been undertaken by all subjects, and two-thirds of the for-profit subjects currently use or have recently used OSC to produce multifamily housing units. The same subset of subjects are very optimistic about external factors, including market demand, the regional economy, interest rates, and the availability of capital.

Those subjects with OSC experience express concerns related to the cost of OSC.

4.4.2. Environmental Factors

The top-4 most prolific incumbent landlords control less than 2% of non-owner-occupied housing units, i.e., they produce less than 2% of rentable multifamily shelter in our study area (Demeter, 2017; "U.S. Census," 2017). And those same landlords don't make production decisions unilaterally; rather, they

are part of a consortium of necessity—four stakeholder groups that make go/no-go production decisions, independently of one another, responding to often conflicting incentives.

5. Discussion and Conclusions

5.1. Summary of Research

Los Angeles is experiencing a housing crisis characterized by a housing shortage and a lack of housing affordability. The cost of housing is so high that about half of Angelenos spend most of their combined household income on housing, and even still vacancy is below 5% (*FreddyMac Multifamily 2019 Outlook*, 2019; Lee, 2016; "Millions of Americans Burdened by Housing Costs in 2015," 2015; Reid et al., 2017). There's just not enough housing and the little that does exist is astronomically high.

In any competitive market, high prices coupled with short supply will signal increased production, which creates downward pressure on price until the market reaches equilibrium (Marshall, 1890); but the model isn't working—prices are going up, not down (Blumberg & Varghese, 2019; Woo, 2016)—a good indicator of a market failure. New research points to oligopolistic market failure to explain the current crisis (Cosman & Quintero, 2018; Marshall, 1890; Shapiro, 1989; Sweezy, 1939).

Policy solutions have focused on incentives, subsidies, and quotas (Chiang et al., 2015; Eriksen, 2009; Glaeser & Luttmer, 2003; Kimble, 2007; Mukhija, Regus, Slovin, & Das, 2010; Salsich, 1995; Schwartz & Wilson, 2008; Skak & Bloze, 2013; Summers, Cuomo, & Reno, 2000; Tilburg, 2017; Tucker, 1998; Williamson, 2011). They do not focus on healing a market failure, so it's not surprising that efforts to solve the problems have been unsuccessful.

There is broad consensus in the existing literature that off-site construction could increase speed and quality of production. Off-site construction falls into the broader category known as modern methods of construction (MMC). "The adoption of MMCs is

low, despite their well-documented benefits” (Rahman, 2014, p. 75). Off-site construction has been studied as a method in the U.K., Canada, China, Hong Kong, Australia, Japan, Switzerland (Arashpour et al., 2017; Blismas et al., 2006; Boyd et al., 2013; Gann, 1996; Girmscheid & Rinas, 2012; Goodier, 2005; Hampson & Brandon, 2004; Hosseini et al., 2018; Jin et al., 2018; Kamali & Hewage, 2016; Lawson et al., 2012). But not a single peer reviewed study was found that looks at off-site construction in the Los Angeles Metro region. This gap is a critical one for the academic community considering that Los Angeles is the second largest city in the U.S. and arguably the epicenter of the American housing crisis. Increased understanding of the policy environment, both public and private, related to the adoption or rejection of off-site construction helps to inform studies in other disciplines, including: urban planning, business, architecture, engineering, finance, and environmental science.

Existing scholarship has explored off-site methodology, measuring cost (Mao et al., 2016; Xue et al., 2018), sustainability (Jaillon & Poon, 2008; Tam et al., 2007), efficiency (Becker, Shane, & Jalselskis, 2012), etc., but this study is the first to examine off-site construction through the lens of the housing crisis as an economic market failure.

The preponderance of support from big consulting and the academic literature indisputably establishes off-site construction’s speed advantage over traditional construction methods, and speedier production would result, *ceteris paribus*, in more profitable housing production. Big-5 consulting berates the construction industry for clinging to antiquated methods and strongly recommends industrialization, specifically calling for off-site (Borgogna et al., 2015; Bughin et al., 2017; Evans-Greenwood et al.,

2019; *EY - Construction sector transformation: The productivity drivers*, 2018; Threlfall, 2016).

Despite the overwhelming consensus of both academic studies and business consulting, the message does not appear to have been received by the builders of multifamily housing in Los Angeles. Half of the subjects in this study have used OSC on a recent build and are receptive to using it again, but even still, OSC is not widely used in Los Angeles. The academic community has asked ‘why not?’ Off-site methods have gained popularity in other places around the world (Arif et al., 2012; Goodier, 2005; Nadim & Goulding, 2011; Pan et al., 2012; Pan & Goodier, 2012; Rahman, 2014; Tam et al., 2007; Wu et al., 2019), but Los Angeles is missing from the conversation.

Recent research suggests that oligopoly theory, discussed in Paul Sweezy’s 1939 scholarship, *Demand Under Oligopoly*, and Carl Shapiro’s 1989 chapter, *Theories of oligopoly behavior*, may be an appropriate model to explain housing production shortfalls in the Los Angeles rental housing market (Shapiro, 1989; Sweezy, 1939). The nationwide research from Johns Hopkins, by Cosman and Quintero, is based on the supposition of concentrated market power in major American cities. Market performance seems to support their theory.

This research is necessary because it extracts Los Angeles Metro from the national analysis and isolates it as a case study of decision-making specific to the region. It captures market dynamics related to LA’s housing crisis (Creswell, 2014; Gerring, 2004; Miles, 2014; Morse & Richards, 2013; Yin, 1989) within the theoretical framework of supplier theory, specifically oligopoly theory (Marshall, 1890; Shapiro, 1989; Sweezy, 1939).

The inquiry format is a qualitative case study methodology using oral and written questions, directed to the decision-making executives who make production decisions for the most prolific, incumbent, multifamily landlords in the LA Metro region. It explores possible motivations regarding their failure to fully exploit off-site construction to increase multifamily housing production.

This research contributes to academic understanding by testing the Los Angeles market for evidence of Cosman and Quintero's recent assertion that underproduction of housing can be explained through the theoretical framework of oligopolistic market failure (Cosman & Quintero, 2018; Shapiro, 1989; Sweezy, 1939). Any contribution to the root-cause quest related to urban housing crisis is important, but this study does more than help us to understand why the housing crisis exists. It also hints at how it can be mitigated. Substantial evidence is compiled in support of OSC that, by consensus opinion, could fundamentally and dramatically improve the production of new housing, and increase the availability of lower-cost, higher-quality shelter.

5.2. Analysis and Synthesis

5.2.1. Responses Collected from Subjects

Subjects indicate a preference to build new housing over buying existing inventory and all subjects report an expansion in their housing unit inventories since the 2017 YARDI® Matrix data was compiled (Demeter, 2017). Inventory expansion alone does not rule out a strategic bias toward constraining market production; in fact, oligopolists would be expected to compete with one another for market share, so capturing a larger share of existing inventory would not be inconsistent with oligopolistic incentives. However, when taken together, the express preference to

expand their own unit count by adding new inventory to the market instead of absorbing market share from competitors runs counter to the expected market behavior of an oligopolist. The preference to build new housing indicates a willingness to increase overall market production of shelter.

Subjects report that they have used of OSC methods on recent projects. OSC has been lauded by both the academic and business communities as a strategy to increase production efficiency and shorten timelines (Bertram, Fuchs, et al., 2019; Nadim & Goulding, 2011). Both of these outcomes would be expected to increase market production levels; so, the adoption of OSC technology can be interpreted as willingness to introduce higher production productivity, accelerate timetables, and increase market production.

Not all subjects are politically active, but those who are report opposition to Proposition 10, California's 2018 rent control initiative. According to Beacon Economics, rent control is an effective barrier against new housing production (Thornberg & Haveman, 2007), so opposition to rent control could be interpreted as a pro-development stance. However, Proposition 10 would also likely impose oppressive limits on multifamily rental income, so the issue is sophisticated and difficult to interpret as an indicator of either a competitive or failing market.

5.2.2. Environmental Factors

Market concentration is the defining measure of oligopoly “[...]which is a market with only a few sellers, each offering a product that is similar or identical to the products offered by other sellers. Economists measure a market's domination by a small number of firms with a statistic called the *concentration ratio*, which is the percentage

of total output in the market supplied by the four largest firms” (Mankiw, 2009, p. 346). This type of market concentration can also be measured and expressed as a value of the Herfindahl-Hirschman Index (HHI).

Despite their unit inventory increases, the most prolific multifamily landlords in Los Angeles control a very small percentage share of the market, scoring a 0.02 concentration ratio and an HHI of only 3.025. Such low market concentration mathematically rules out oligopoly in the Los Angeles Metro multifamily housing market. The U.S. Federal Government considers markets with an HHI below 1500 to be unconcentrated (United States. Dept. of Justice & United States. Federal Trade Commission, 2010, p. 19).

Economic models rely on rational market actors making well-informed self-interested decisions. And strictly speaking, this may be an accurate depiction in the production of shelter as a service, but not in the production of housing from which shelter is derived. Housing, like other outputs of real estate development, is produced through a non-collaborative process, by four separate decisionmakers, with conflicting motives, and therefore cannot be classified as a discrete rational actor in an economic model to predict market behavior under oligopoly.

5.3. Evaluation

This study addresses a key question within an important and salient policy area. Presently, housing/shelter, and homelessness are so important to the public that in both the City of Los Angeles and Los Angeles County, residents recently voted to tax themselves to fund solutions (*Proposition HHH / Measure H: How It Happened and Lessons Learned*, 2018, p. 1). The voting public is anxious for answers to questions

about how to provide affordable shelter to all Angelinos. Policymakers seek to understand the hurdles to providing shelter, but providing affordable shelter falls mostly within the bailiwick of private real estate developers, not government officials; so it's most important to understand what motivates the real estate development industry to build housing, and what holds them back.

We queried four of the top-6 incumbent landlords who control the most multifamily units in Los Angeles and asked questions about their motivations and practices related to producing new multifamily housing units, and especially using off-site construction to do it.

Ordered by unit count, #s 3, 4, 5, and 6 on the list participated in the study, which provides important insights that are not otherwise available. But the data could have been even more compelling if it had also included the top two landlords by unit count. The two top-6 landlords that did not participate in our study, Essex Property Trust and Equity Residential are both publicly traded companies. We pulled data from their 2017 and 2018 10-K filings to the SEC. Both companies group Los Angeles Metro properties into a broader 'Southern California' grouping which is inclusive of San Diego, Santa Barbara, etc. According to its SEC filings, Equity decreased its Southern California unit count from 16,160 to 15,968, a decrease of about 1.2% between the end of 2017 and 2018; Essex decreased its unit count from 27,613 to 26,695, about 3.3% over the same period.

These regional decreases for all of Southern California do not provide definitive information about the companies' holdings in Los Angeles Metro, a subset of Southern California. By comparison, AvalonBay did participate as a study subject and indicated

that its LA Metro portfolio is increasing though their SEC filings show a decrease in its Southern California unit count between the end of 2017 and 2018, from 13,330 to 12,883, a 3.4% regional decline. Conversations with the executives of Equity Residential and Essex Property Trust, as well as a follow-up interview with AvalonBay, would have been preferred to speculation about their loosely related SEC data trends. Absent further discussion, the apparent decline in Southern California regional unit counts, coupled with an increase in Los Angeles Metro unit counts prompts as many questions as answers.

5.4. Compare Findings to Literature

Academic inquiry related to off-site construction tends to gravitate to three recurring themes: 1) how viable is the off-site method? (Blismas et al., 2006; Boyd et al., 2013; Gann, 1996; Jaillon & Poon, 2008; Jaillon & Poon, 2010; Jiang, Mao, Hou, Wu, & Tan, 2018; Kamali & Hewage, 2016, 2017; Lawson et al., 2012; Mao et al., 2016; Sadafi et al., 2012; Sonogo, Echeveste, & Galvan Debarba, 2018; Thuesen & Hvam, 2013), 2) what is preventing widespread adoption? (Gan, Chang, Zuo, Wen, & Zillante, 2018; Goodier, 2005; Hong, Shen, Li, Zhang, & Zhang, 2018; Nadim & Goulding, 2011; Pan et al., 2012; Pan & Goodier, 2012; Rahman, 2014; Tam et al., 2007), and 3) how can off-site technology be improved and refined? (Arashpour et al., 2017; Arashpour, Kamat, Bai, Wakefield, & Abbasi, 2018; Arashpour, Wakefield, et al., 2018; Arashpour, Wakefield, Abbasi, Lee, & Minas, 2016; Arashpour, Wakefield, Blismas, & Maqsood, 2015; Arashpour, Wakefield, Blismas, & Minas, 2015; Arif et al., 2012; Becker et al., 2012; Gann, 1996; Girmscheid & Rinas, 2012; Li, Hong, Fan, Xu, & Shen, 2018; Lou & Kamar, 2012; Maas & van Eekelen, 2004; Nahmens & Ikuma, 2012; Nawari, 2012; Taghaddos, Hermann, & Abbasi, 2018; Thuesen & Hvam, 2013; Wood, 2012).

Additionally, some literature reviews the state of the industry and the state of the research (Anderson, 2014; Hampson & Brandon, 2004; Hosseini et al., 2018; Jin et al., 2018; Wu et al., 2019; Xue et al., 2018).

This study best associates with the second theme which asks what is preventing widespread adoption. Previous research has aggregated data from large samples (Gan et al., 2018, p. 10; Goodier, 2005, p. 149; Rahman, 2014, p. 71), but this study is very deliberately constrained to the companies most likely to be motivated by oligopolistic incentives. Despite the narrow focus, both the subjects of this study and those of both Goodier's and Rahman's research share cost as a top concern (Goodier, 2005, p. 153; Rahman, 2014, p. 72). But neither existing study, nor this study, itemizes distinct inputs to cost; so, data related to cost concerns fail to discriminate between transportation cost, production cost, financing cost, cost of risk, etc. Further decomposition of cost in any category reveals a tier of measurable constituent inputs, e.g., production cost can be broken down into: personnel, raw materials, tools & equipment, holding cost, etc.

Aside from failing to thoroughly decompose the subjects' concerns, the research also fails to account for the disparate levels of OSC practitioner competence. Experienced, highly-skilled practitioners would presumably achieve more favorable outcomes than practitioners with less skill and experience; so, both outcomes and any potential resulting concerns, would likewise be expected to vary in correlation to the competence of the OSC practitioner. Subject's concerns that include information related to their history with competent and/or incompetent OSC practitioners would almost certainly vary relative to the level of competence demonstrated by the practitioner(s) with whom they share history. Subjects that have participated in, or are otherwise aware of,

development projects run by incompetent OSC practitioners would be expected to express concerns about OSC as a method, while subjects that have participated in, or are otherwise aware of development projects run by competent OSC practitioners would be expected to express fewer concerns, if any.

5.5. Implications of Findings

The data and environmental factors are indicative of a competitive marketplace, not oligopolistic market failure. Policymakers will form housing strategy based on their understanding of the problem and its root causes, so the ability to discern between a competitive market and a market in oligopolistic failure is essential to effective intervention of the housing crisis.

Armed with evidence that the housing market is not constrained by oligopolistic business practices, bureaucrats and legislators are empowered to narrow the target of regulations and incentives toward other possible contributing factors to underproduction of housing and shelter.

The literature highlights OSC as a potentially powerful strategy to increase housing production and provide more affordable shelter. Further revelations in the data identify some impediments to the adoption of OSC by the development community, specifically concerns related to cost. This particular data point is significant in that it could serve as a lever for policymakers intent on increasing the speed and volume of housing production—policy designed to reduce the cost of OSC could promote adoption and potentially provide positive outcomes for affordable housing and shelter.

The data also reveal that the most prolific incumbent landlords in LA Metro, are optimistic about external factors, i.e., the market, preference to build new housing over

buying from existing inventory, and have demonstrated real interest in OSC. These factors, taken together, reinforce the supposition that policy designed to relieve impediments to the adoption of OSC would likely help mitigate shortages of affordable housing.

5.6. Recommendations for Future Research

The pressing “big question” under which this research falls is ‘Why isn’t off-site construction being used as a common method of housing production in Los Angeles Metro?’ Recent quantitative research suggested oligopoly as a viable model to explain the national housing shortage and affordability crisis, but direct query responses from the landlords with the greatest market shares in Los Angeles Metro definitively eliminate oligopolistic motivations as an explanation for their low adoption of OSC. There are, however, many other possible explanations that have not been tested. For instance, our dataset includes some datapoints that were not previously discussed.

Those that have adopted off-site construction for previous projects were asked if they considered their use of OSC to be successful, and if they planned to use the method again. To the first question, they answered with mixed results; one reported great success and another reported unexpected complication. Despite their varied experience, both indicated that they would use OSC again. Both identified several obstacles related to moving forward. *Cost* and *schedule* were shared concerns, so research related to mitigating those concerns could help to fill the ‘why?’ gap. Transportation is one part of the off-site process that contributes to increases in both cost and schedule duration, so research that identifies the intersection between likely active multifamily development

markets and viable locations for off-site production facilities could provide invaluable information to the off-site construction industry.

Another area of research that has not yet been undertaken is the decomposition of subjects' concerns to a level of measurable and addressable specificity. For instance, a hyper-specific breakdown of research subjects' concerns about project cost could single out more specific elements of cost, e.g., the cost of transporting finished units from manufacturing facilities to jobsites; or perhaps, the cost of reengineering building plans from standard in situ construction to accommodate off-site construction methods. Awareness and understanding at this level of specificity could be invaluable to the task of addressing concerns by improving processes directly related to those specific concerns.

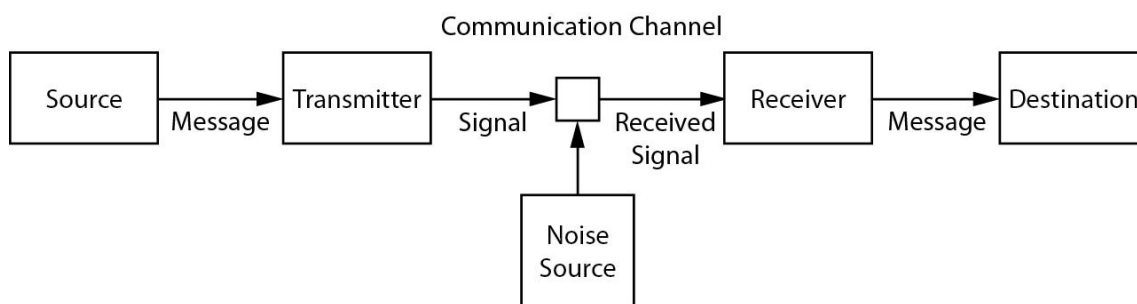


Figure 7

This research, however, is specifically in pursuit of a viable theoretical framework within which to understand the low adoption rate of OSC in the production of multifamily housing, using Los Angeles Metro as the test area. The literature has established overwhelming evidence of the efficacy of OSC in terms of speed, safety, quality, and cost. Big-5 business consulting unanimously endorses OSC. But adoption is low, almost as if those responsible for making the decision whether or not to adopt have literally not gotten the message.

Seventy years ago, the University of Illinois published two papers together in a single volume, one by Claude E. Shannon and the other by Warren Weaver. The published volume was given the title, *The Mathematical Theory of Communication* and it has become a seminal work in the field of communication theory. Their work establishes the model, as shown in *Figure 7*, whereby a message originates from a source, is encoded from a message to a signal by a transmitter, and sent via communication channel to a receiver, which decodes the signal back into the message for delivery to the destination. Along the way, the signal may be distorted, corrupted, or even interrupted by noise (Shannon & Weaver, 1949).

For adoption of OSC to occur, 1) those who would make decisions to adopt must communicate their decision variables to OSC operators, and 2) OSC operators must communicate to decisionmakers how OSC addresses the decision variables. Communication must flow in both directions. If low adoption of OSC, even in the face of consensus support is the result of a breakdown of communication between these two specialisms, with different jargon and different priorities, Shannon and Weaver's communication model could serve as a useful theoretical framework within which to understand the breakdown. Isolating a failure in one or both directions of flow and further isolating in which node of Shannon and Weaver's model the breakdown occurs would represent unprecedented granularity that could spawn testable hypotheses. We recommend explanatory research of low OSC adoption, examined through the theoretical framework of Shannon and Weaver's communication model.

5.7. Conclusions

Subject responses did not signal any of the four behavioral markers identified and accepted as characteristics of oligopolists: 1) avoidance of increasing market production of new multifamily housing, 2) preference to buy instead of to build, 3) resistance to greater efficiency in production methods, e.g., OSC, and 4) a tendency to downplay the market as a favorable environment for multifamily housing development. Rather, data indicate aggressive growth, as would be expected in a competitive market—no indication was found that subjects are engaged in deliberate constraint of production.

Dramatic market concentration observed by Cosman and Quintero in 60% of U.S. markets (Cosman & Quintero, 2018, p. 3) does not exist in the Los Angeles Metro multifamily housing market (Demeter, 2017; "U.S. Census," 2017, 2013-2017 American Community Survey 5-Year Estimates, table DP04). Market concentration in that sector is extremely low, ruling out oligopoly as a major contributing factor to inadequately low multifamily housing production in LA Metro.

Related to subjects' resistance or receptivity to the adoption of OSC, receptivity has been demonstrated by recent and current use of OSC, though Subject 3 reports experiencing "delays and excessive field modification that resulted in inefficiencies and poor quality." The same subject was asked if that method would likely be used again, to which the response was, "No." But when asked more generally about OSC in future development plans, Subject 3 responded, "We might revisit this method in the future if we can get comfortable with the level of coordination during plan development and use a higher degree of repetitive building elements in the design."

Subject 2, has had a more positive experience, sharing, “Off-site framing has been very successful in improving quality with tighter tolerances producing less construction waste” and responding with an unqualified “yes” to both questions related to employing OSC on future projects. The final for-profit study participant, Subject 4, is not familiar with multifamily OSC.

Subjects share a positive market outlook which is supported by their aggressive pattern of growth through new construction. Interest in OSC is strong enough that even the subject with a history of OSC challenges is willing to try again. Cost and schedule have been raised as concerns by 50% of subjects, so addressing challenges in these two areas may be an effective way to increase receptivity to OSC.

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