The Financial Impact of Healthy Buildings at The Massachusetts Institute of Technology

by

Natasha Sadikin

Bachelor of Arts - Architectural Studies, 2013
University of California, Los Angeles

Submitted to the Program in Real Estate Development in Conjunction with the Center for Real Estate in Partial Fulfillment of the Requirements for the Degree of Master of Science in Real Estate Development

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Signature of Author ______________________________

Center for Real Estate
December 09, 2020

Certified by ______________________________

Dr. Andrea Chegut
Research Scientist, MIT Center for Real Estate
Thesis Supervisor

Accepted by ______________________________

Professor Siqi Zheng
Samuel Tak Lee Professor of Urban and Real Estate Sustainability
Faculty Dicrector, MIT Center for Real Estate & Sustainable Urbanization Lab

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Abstract

While the benefits of healthy spaces have long been qualitatively understood and appreciated, it has not been financially analyzed to derive their value and impact on economic decision-making. We use CompStak and Healthy Building public databases from Fitwel and WELL to operationalize a real estate hedonic model in order to ascertain the value of healthy spaces on the effective rent of offices spaces in ten cities within the United States: Atlanta, Boston, Chicago, Denver, Los Angeles, New York, Philadelphia, San Francisco, Seattle, and Washington DC.

We find that healthy building effective rents transact between 4.4 and 7.7% more per square foot than their nearby unhealthy neighbor peers. This premium for healthy spaces is independent of all other factors, such as LEED certification, building age, renovation, lease duration, and submarket. These results indicate that healthy buildings are seen as an asset that correlates with employee or tenant well-being and productivity.

Thesis Supervisor: Dr. Andrea Chegut
Title: Director, MIT Real Estate Innovation Lab

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Amidst COVID-19 and all the unfortunate events that have happened this year, I am very grateful for your stable presence, your patience in me, and your dedication and care invested not only in my academic exploits but also in my personal life and career as well. I will always fondly remember our 6+ hour zoom calls whilst troubleshooting R studio together. Thank you for believing in me and turning a non-numbers person into a data-science coding monkey! I also want to extend my thanks to the lab manager, Erin Glennon, for keeping such a tight ship and keeping us labmates connected. We really can’t do anything without you!

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To the 2020 CRE cohort - Although our time was short, I know the friendships and bonds we’ve made will last a lifetime. I look forward to seeing the splashes you each make in the Real Estate field.

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All of your commitment and dedication to me and our friend group sets a high standard for friendships everywhere. Thanks for always being there to listen to my troubles, help me with graphic layouts, and listen to my healthy buildings presentation for the umpteenth time. In short, you are all the bestest friends a girl could ask for. I hope we can all see each other again very, very soon.

Lastly, my family. Thank you to my parents for believing in me and my desire to learn. Without you all, I wouldn’t be here.

Table of Contents

List of Figures & Tables

Figures

Equations

Tables

Chapter 01

Introduction

Around the world, many communities are facing troubling health trends. Though people are living longer, they are leading less healthy lives. By 2030, a projected 52 million people will die due to chronic diseases caused by poor lifestyle. This is five times the amount of communicable diseases (Global Health Observatory GHO data).

In the face of these problems, the impacts of the building environment have become an increasingly important factor in combating these risk factors given the average American spends 90% of their time indoor (Allen et al., 2016), and out of that time, a significant portion of that is spent in the workplace. Health does not stop at the hospital, it starts in our homes and our work, and our everyday life. Environmentally, social, behavioral, and even the decision of what part of the city to live in all have impacts on our health.

So, how do we define a Healthy Building?

The World Health Organization (WHO) defines a healthy building as a space that supports the physical, psychological, and social health and well-being of people. This interest in a more holistic approach to real estate has been implemented in a wide range of design strategies and certifications. While there has been research done to reflect the potential economic impacts of Smart, Connected, and Green (Keitaro et al., 2018), there has not yet been research done to reflect the impacts of Healthy-Certified Buildings.

This is because healthy-certified standards are new and recently established, with Fitwel and WELL certification programs leading the charge in the United States. With the advent of COVID-19, there is now greater urgency for real estate owners in providing a safe, healthy space for tenants and residents to occupy. Ultimately, we hope this helps owners better understand the benefits and implications of healthy buildings.

In this project, we take the first step towards understanding the financial impact of Healthy Buildings on achieving effective logged rents. We use CompStak and Healthy Building public databases from Fitwel and WELL to operationalize a real estate hedonic model in order to ascertain the value of healthy spaces on the effective rent of offices spaces in ten cities within the United States: Atlanta, Boston, Chicago, Denver, Los Angeles, New York, Philadelphia, San Francisco, Seattle, and Washington DC.

Our identification strategy seeks a rigorous matching strategy for the time and location of the healthy space. After identifying healthy 407 projects spanning across 2,322 healthy space rental contracts, we then extract CompStak rental contract data points and match these with nearby healthy spaces in the same market to ensure neighborhood quality controls.

Based on the results within our regression analysis, we observe that health-certified spaces, both registered and certified, transact between 4.4 and 7% more per square foot than their nearest non-certified neighboring peers. This premium for healthy spaces is independent of all other factors, such as LEED certification, building age, renovation, lease duration, and submarket. Our analysis of our variables explains 65 to 70% of the variation in the effective rents per square foot. Also, the results show that health certified buildings are positive, economically and statistically significant (*). These results indicate that healthy buildings are seen as an asset that improves employee or tenant well-being and productivity.

The rest of this thesis is outlined as follows.

Chapter 3 provides an overview of healthy buildings, offers a primer into how health has shaped design, as well as explore a building owner's incentive towards building healthy spaces.

Chapter 4 dives into current market players in the healthy-certification programs within the United States as well as explain some of the most common healthy features.

Chapter 5 looks at the current typical valuation methods for the commercial real estate industry as well as look at a transaction-based methodology that is used by this research study.

Chapter 6 describes our data collection and methodology as well as the hypothesis of our research question.

Chapter 7 discusses the results of our regressions split into four different models.

Chapter 8 concludes with our discussion and considerations.

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Chapter 02

Healthy Buildings: An Overview

The concept of health in the built environment, and its effect on our understanding of physical and mental health, has been around for hundreds of years. From sanitation during Roman times with the introduction of sewers, public baths, and toilets; to the 1916 New York Zoning resolution that sought to ensure access to light and air to the streets with the increasing growth of high-rise buildings; to published research citing the benefits and challenges of natural ventilation compared to mechanical ventilation provided by traditional HVAC units, it is clear that the idea of healthy environments is here to stay.

In this chapter, we explore the history of healthy buildings, the role of pandemics to act as a catalyst for adopting new protocols of health, and why owners everywhere need to understand that healthy employees increase value both for the environment and for their productivity. Ultimately, amidst the current global COVID-19 pandemic, institutions and businesses at every level must strategize on how to restart our daily normalcy, but more importantly, how to provide a safe, healthy space for all of us to occupy.

2.1 Lessons from History: Pandemics as Catalyst

This awareness of health and building has been evolving throughout moments in history, but pandemics, particularly, lead to leaps in advancement. Pandemics are not new: the spread of the infectious disease has been paramount to the shaping of cities and often acts as a catalyst for adopting new protocols of health. COVID-19 is just one of many diseases that have plagued our society, like the 1918 Spanish Flu that infected 500 million and killed up to 50 million, or the 2003 SARS outbreak in Asia that had a 30% mortality rate (Zhou et al., 2020)2019, Wuhan, China, has expe-

GOVERNANCE

Government-led social distance is key to pandemic response and needs to be implemented early to be successful. Public parks were first a refuge to restore health to overcrowded, industrial towns.

DESIGN

Early 20th century architects saw design as a panacea to the sick, overcrowded cities. The Sanitary Movement impacted bathroom and building materials - a shift from mainly wood facades to tile to mimic the cleanliness of hospitals.

rienced an outbreak of coronavirus disease 2019 (COVID-19. In reviewing how the built environment shifted after pandemics to accommodate public health, we find two key areas: Governance and Design.

Governance

We can learn a lot from previous pandemics. Strategies that were implemented a hundred years ago are still, surprisingly, relevant today. Most importantly, coordinated government-level (municipal, state, federal) response to public health is crucial for cities to regain order. Urban planning and regulation came into play to help with sanitation, fire, and safety, often playing the first line of defense.

In 1918, much of the U.S. lived with "poverty, poor nutrition, poor hygiene, household/ community-level crowding, and a lack of preparation of the population and decision-makers due to cognitive inertia and poor medical and insufficient nursing care" (Pambuccian, 2020). Early predictions had most of the elite class looking down on “workers, the poor, and colored folk” (GALISHOFF, 1985) as naturally prone to disease rather than their dense living conditions. These pandemics ultimately revealed an important truth: the disease was inescapable by any social class. As Cyrus Edson, a physician and New York City health commissioner, states in his 1895 article, “Disease binds the human race together as with an unbreakable chain” (423). Governments had to acknowledge that tackling infectious diseases had to be addressed at a wider level. This gave rise to countries creating dedicated public health strategies and ministries that embraced universal healthcare both at the country level and internationally. 1919 saw the formation of the forerunner of today’s World Health Organization (WHO).

This time period saw a great emphasis on the importance of government-led interventions. The enforcement of strict social distancing early on in St. Louis, San Francisco, Milwaukee, and Kansas City during the 1918 pandemic cut transmission rates by 30 to 50 percent (Bootsma & Ferguson, 2007). Since then, not much has changed. In 2007, a study seeking to understand the correlation between interventions and reduced disease transmission rates (Hatchett et al., 2007) found that cities that implemented multiple interventions at an early phase can significantly reduce influenza transmission, but that viral spread will be renewed upon relaxation of such measures. These include mandates to close schools, shops, restaurants, businesses, and placing restrictions on group gatherings and enforcing social distancing. In this way, the methods utilized then are not dissimilar to the same practices we all experience now in 2020.

Design

In response to pandemic outbreaks and the associated advancements in medical science, 20th-century architects saw design as a way to address health in the built environment. For example, Robert Koch’s discovery of tubercle bacillus in 1882 led to the Sanatorium movement (McCarthy, 2001) in Europe and the United States. Because medical treatment for tuberculosis was nonexistent at this time, its treatment was environmental: open-air treatment, mental rest, and daily walks with outdoor sun exposure..

Such clinical facilities and methods inspired a new modernist architecture that prioritized hygiene, sunshine, air, healthiness, and whiteness starting in the 1920s and lasting into the late 1970s. In his book, Light, Air, and Openness, architectural historian Paul Overy lays out how many features of modern design originated in hospitals and sanatoria, including all-white patient rooms that were designed not only to be clean but also to symbolize hygiene and health.

At the forefront of this movement stood great architects from Adolf Loos, Alvar Aalto, to Le Corbusier who all curated architectural structures that embodied the original clinical inspiration – a stark contrast to ornament, dust, and clutter, and the reminders of industrial disease-prone cities. Dirt, in particular, was seen as an enemy of hygiene to be eradicated at all costs (OVERY, 2008). These nods to the sanitorium movement are found in Le Corbusier’s Five Points of Architecture where he encourages horizontal ribbon windows, enabled by a free façade, to be used for lighting rooms evenly, and flat roofs that could host a roof garden (Corbusier, 1986).

Figure 2-1 Paving the Way for Healthy Buildings (Global Wellness Institute, 2018)

As a result, minimalist design and materials in the 1920s replaced ornate wood carvings and upholstery. Textures were replaced with materials that were lightweight and easily cleanable: steel, white tile, plywood. This was most prevalent in the re-design of bathrooms and kitchens in the typical home. White tile replaced wooden floors; toilets became one-piece designs to ensure cleanliness; and wallpapers became unpopular due to concerns over arsenic (R.C. Kedzie, 1874). Concern over hygiene also drove demand for the now typical powder room on the first floor of a multi-level house. This allowed guests and delivery people to wash their hands without going to the second floor of the home, traditionally meant for a family's personal quarters.

In the end, pandemic-inspired governance and design changes in the 20th century began to shape our modern conception of health-oriented lifestyles and buildings.

2.2 Paving the Way for Healthy Buildings

The idea of health-oriented design is not new. Since the 19th century, there have been dozens of planning, building, and design movements that have attempted to address particular problems in our homes and communities (Figure 3-1). From designing intentional communities that bring like-minded people together to share lifestyles, values, and beliefs; to the formation of wellness getaways and resorts; or even to design-driven and green/sustainable building movements; there have been countless moments that have paved the way for health-oriented communities and buildings (Global Wellness Institute, 2018).

So, what is a Healthy Building?

The World Health Organization (WHO) defines a healthy building as a space that supports the physical, psychological, and social health and well-being of people.

Some examples of healthy features include active furnishings, operable shading, natural views, green purchasing policies, fitness rooms, no-smoking policies, no asbestos, natural daylight, ventilation, filtration, air quality, and even water treatment.

A healthy building is essentially a group of features that extends current Green Buildings features: not only environmentally responsible and resource-efficient building characteristics, but also integrating health, wellness, and human experience in the building. While this definition may seem broad, the current pandemic clearly illustrates that many of our buildings fail to meet these guidelines.

In 1984, a WHO report suggested that up to 30 percent of new and remodeled buildings worldwide may be the subject of excessive complaints related to indoor air quality (Definition of Sick Building Syndrome, n.d.).

The issue of sick buildings becomes more prevalent as we find that the average American spends up to 90% of their time indoors where inhalation exposure is continuous (Allen et al., 2016), and our largest exposure to pollutants, both indoor and outdoor, occurs indoors. Our indoor built environment represents a crucial opportunity to enhance factors that impact our health. Poor air quality has an impact on short-term sick leave, asthma, and respiratory infections (Sundell et al., 2011). Given that in the United States, where most people's health costs are directly tied to their employers who

Definition

Healthy Building

A space that supports the physical, psychological, and social health and well-being of people.

contribute to their health insurance (a range from $14,000 to $20,000 per employee per year on average), companies have a strong incentive to keep their employees healthy.

2.3 An Owner's Incentives for Healthy Buildings

The rise of healthy buildings, and by extension, healthy employees, can provide many benefits for owners. For data of more than 3,000 workers over 40 buildings, research shows that 57% of all sick leave was due to poor ventilation (Milton, 2000) and even something as simple as a "pollution source", like a dirty carpet, workers are reporting more headaches and working 6.5% more slowly (Wargocki, 1999a)Sick Building Syndrome (SBS. Dodge Data & Analytics' Drive Towards Healthier Buildings SmartMarket Report found that 78% of owners report seeing a medium to high improvement on their healthy investments (Petrullo et al., 2016a). Most interestingly, owners, architects, interior designers, and contractors all have differing levels of interest and reasons for implementing healthy building features. However, the top three features amongst all stakeholders are improved indoor lighting conditions and daylighting (77%), enhanced thermal comfort (64%), and enhanced ventilation (58%).

Despite these benefits, the survey (Figure 3-2) found that an owner's biggest challenges in implementing healthy buildings are (1) budget concerns, (2) need to prioritize other items such as energy performance and green certification, (3) unclear business case for prioritizing health and well-being, (4) lack of client interest and, (5) lack of expertise.

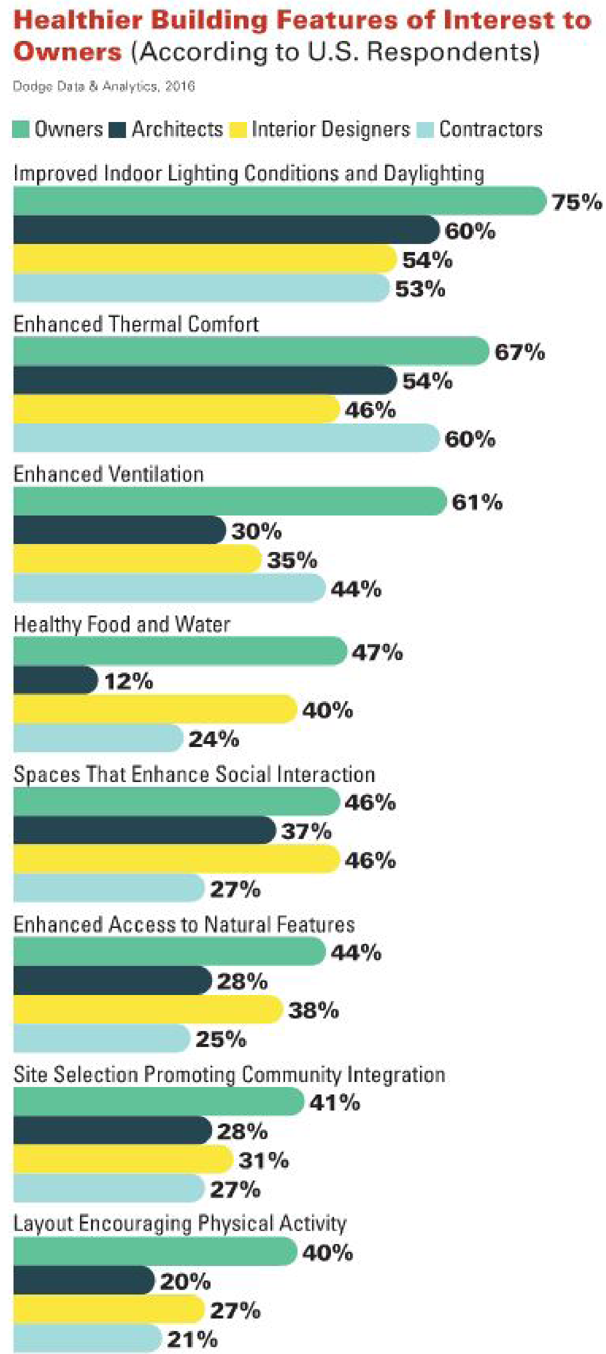


Figure 2-2 Building Features of Interest (Petrullo et al., 2016a)

While many health features have had their place in green buildings, they are now increasingly becoming a set of features that stands on its own with extensive research pointing to value in each feature case. We take a deeper dive into examining both the qualitative and quantitative values of the top healthy building features in Chapter 4.

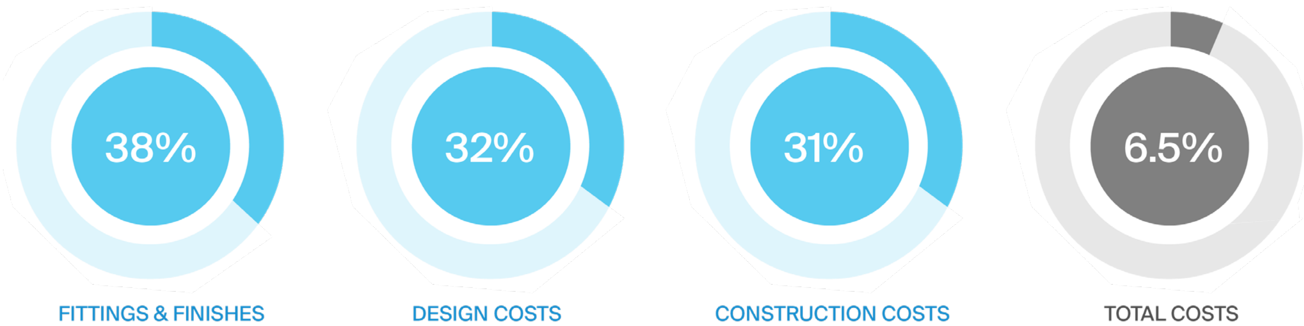


Figure2-3 Typical Green Building increase in costs (A. Chegut et al., 2019)

Given these potential premiums, health and well-being are also emerging as key market differentiation opportunities for companies and owners around the world. Healthy features stand to pay back in both qualitative and quantitative benefits. It far exceeds per-person energy costs relative to salary costs. On a broader economic scale, researchers at Lawrence Berkeley National Laboratory have estimated that improving air quality can add up to $20 billion annually to the US economy (W. J. Fisk et al., 2011). These new insights should help owners feel comfortable in justifying their investments towards healthy building features.
Additionally, the Global Real Estate Sustainability Benchmark (GRESB) has provided institutional investors with data and analytical tools to manage environmental, social, and governance (ESG) considerations in building operations since 2009. The annual GRESB Real Estate Assessment benchmarks the ESG performance of real estate funds and in 2016, GRESB worked with the Green Health Partnership to release the GRESB Health and Well-being module (Worden, Kelly, Pyke, Christopher, Trowbridge, 2018) which assesses the presence of processes to promote the health and well-being of employees, tenants, customers, and communities. More importantly, this move reflects an institutional and fund-level interest in health-centered real estate assets, signaling positive growth for healthy initiatives moving forward.

2.4 The Price of Innovation

While Healthy Buildings are still relatively new in the market, we take a clue on how these buildings might be received based on precedence research done on Green Buildings. Energy-efficient, green construction practices can have a substantial impact on environmental outcomes: buildings represent 30 percent of global carbon emissions (Kahn et al., 2014) and 40 percent of raw materials and energy consumption (Glaeser & Kahn, 2008). Currently, green buildings represent only 5.4 percent of commercial office stock and an even smaller percentage in other real estate sectors. Despite the data showing that they have a value premium, ranging from 13.3 to 36.5 percent on transaction prices (Piet Eichholtz et al., n.d.), why then, are green buildings not more prevalent?

One thought is that the value premium reflects not only cost savings and risk perception, but also the reality of higher construction inputs required to construct. In The Price of

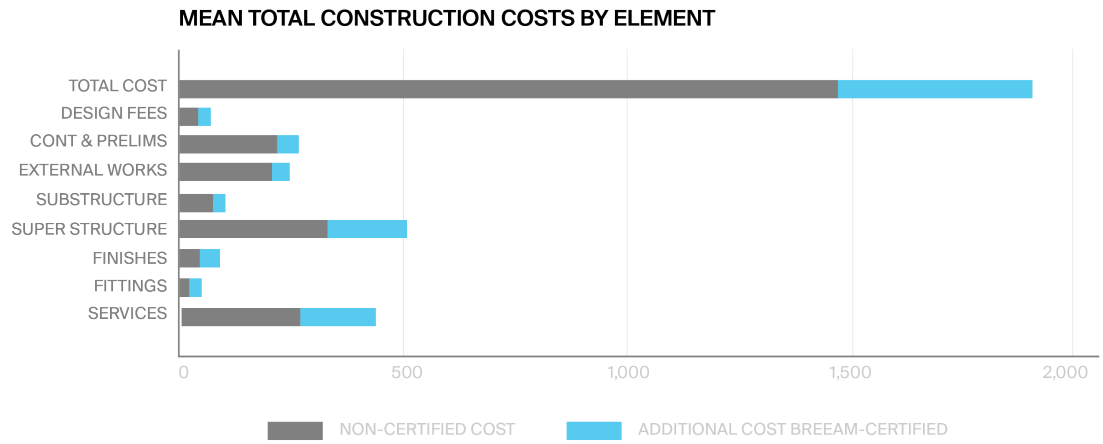


Figure 2-4 Mean Total Construction Costs by Element (A. Chegut et al., 2019)

Innovation: An Analysis of the Marginal Cost of Green Buildings (A. Chegut et al., 2019), the study further assesses the marginal cost of more efficient, green construction in an empirically rigorous manner.

Controlling for building and contract characteristics, the paper determines there are higher marginal costs for more efficient, green construction and refurbishment projects: (1) Design costs are 32 percent higher than the costs of conventional building design, (2) Fittings and finishes costs are 32-38 percent higher, (3) Construction costs for highest rated green buildings are 31 percent higher on average, with a large spectrum depending on the "greenness" of the project, and (4) Green building projects take about 11 percent longer to complete.

Despite these increases in costs, the research still finds a positive gap between the average marginal transaction price and the average marginal cost, suggesting that the energy-efficiency gap in real estate may be due to both a market barrier.

In theory, the increase in design fees represents a small percentage (approximately 3%) compared to total costs. So why does it stand as a market barrier? Looking at the real estate development process, the paper notes that design fees are generally paid up-front before construction and traditionally through the developer's own equity. Because of this, the costs associated have a higher level of the risk premium and hinders developers in undertaking the risk associated with undertaking a project that both costs more and also consistently takes longer to finish. Thus, the developer's capital needs to be sunk longer before cash flows can be produced to pay debt service.

In the end, these findings help explain the limited growth of efficient building practices and new design innovations. A better understanding of these barriers will lead to more diffusion of energy-efficient and sustainable building practices, and thus the necessary reduction of carbon externality from the built environment. Thus, it becomes important for owners to understand the benefits, both tangible and intangible, of healthy buildings.

BACK TO BASICS	VENTILATE	FILTER AIR
	Ventilating with outdoor air is vital to diluting airborne contaminants and reducing disease transmission rates	Filtration of recirculated air reduces transmission of airborne, infectious diseases
HUMIDIFY	**CLEAN**	**EDUCATE**
Viruses survive in low-humidity environments	Adjusting cleaning protocols to meet the demands of the current situation	Recommend washing hands often with soap and water for at least 20 seconds

Figure 2-5 Back to Basics approach to COVID-19 (D. A. Chegut & Short, 2020)

2.5 Adjusting to a New Normal post COVID-19

At the very beginning of COVID-19 with everyone first converting to remote work, the media sensationalized the death of the workplace. Why would anyone go back to work, if they could work from the comfort of their own homes?

However, Gensler's Work From Home Survey found that out of 2,300+ full-time U.S. office workers for a company of 100 or more people, only 12% of U.S workers want to work from home full-time. These findings are backed up with other global studies of recent workers, which found that 74% of workers say they missed the "people" factor and the "collaboration" that is brought from working in proximity (Back to the Office 30% 70%, 2020)and less than a third had the choice to work from home. While many of the effects of COVID-19 on the workplace are still unfolding, some points are emerging clearly from our data.

Now, it seems we all have the same question: how do we create healthy spaces? When employees come back to the office, they will be coming back for collaboration and social connection on a face-to-face level. While workers want their workplaces to adapt to these changing times, how a workplace needs to adapt is still open for debate. But one thing is clear: employees expect changes to their workplace to address their health concerns. Businesses will need to continue to adapt to meet the increasing personal concerns of employees who need to be enabled to focus and work safely.

In Automation, Healthy Buildings, and the Future of Work, a recent webinar hosted by MIT Real Estate Innovation Lab and Ernst & Young (EY), industry experts came together with Gensler and JP Morgan Chase to discuss this topic of recommended strategies.

One of the most fundamental recommendations is a back-to-basics approach: ventilate, filter air, humidify, clean, and educate. First, increase ventilation. While recirculating air has become the default in our buildings, ventilating with outdoor air is vital to diluting airborne contaminants and decreasing disease transmission rates. Second, consider the introduction of some full potential high-efficiency particulate air (HEPA) filters which can remove 99.97% of particles that are 0.3 microns or larger. The third, is to maintain optimal humidity because research suggests that viruses survive better in low-humidity environments. Fourth, clean where you need to by strengthening cleaning protocols. And finally, promote healthy hygiene by posting educational handwashing signage.

COVID-19 has changed the way businesses are thinking about health and safety in public spaces. Moving forward, owners will design and curate spaces with a different set of intentions.

Chapter 03

Healthy Building Market Players and Features

3.1 Market Players

Developers and owners do not have to start from scratch to start their healthy building certification. They can draw upon many design principles and standards to support their wellness needs. Table 4-1 summarizes examples of organizations that provide standards, ratings, or certification on the building-asset level. Different organizations have varying support on the six wellness dimensions: Physical, Mental/Emotional/Spiritual, Social, Environmental, Community, Economic/Finance (PositivelyWell: It's Time to Focus on Health and Wellness - Global Wellness Institute, n.d.).

For asset-level certification, Fitwel Standard and WELL Building Standard are most common in the United States. Since their initial start in the mid-2010s, over 830 projects have registered with WELL and Fitwel in 35 countries worldwide. The main differences between Fitwel and WELL are reflected in Table 4.2.

	Physical	Mental, Emotional, Spiritual	Social	Environmental	Community	Economic/ Financial
Building-Scale						
Active Design Guidelines	X					
Biophilic Design Principles	X	X	X	X	X	
CASBEE Housing Health Checklist (Japan)	X			X		
Fitwel™ Standard	X	X	X		X	
Healthy Active by Design/Healthy Spaces & Places (Australia)	X	X	X		X	X
LEED, BREEAM, & Similar				X		
Living Building Standard	X	X	X	X	X	X
Livable Housing Guidelines (Australia)	X					
Universal/Inclusive/Transgenerational Design	X					
ULI Building Healthy Places Toolkit	X	X	X	X	X	X
WELL Building Standard™	X	X	X	X	X	

Table 3-1 Rating/Certification Systems and Design Principals that Support Building for Wellness (PositivelyWell: It's Time to Focus on Health and Wellness - Global Wellness Institute, n.d.)

WELL

Developed by Delos, a wellness real estate and technology firm, in 2014, WELL is operated by the International WELL Building Institute (IWBI) and certified by the Green Business Certification Incorporation (GBCI), which administers the LEED certification program as well. Because of this, the Well Building Standard is modeled closely to LEED, but focuses exclusively on impacts to human health and wellbeing through seven sectors: air, water, nourishment, light, fitness, comfort, and mind. The process is rigorous and requires complex documentation including annotated project documents, drawings, and letters of assurance from the project team. A site visit by a WELL assessor is also required. The assessor performs visual inspections and performance tests to evaluate the seven sectors. Well Building Certification requires a project to re-certify every three years to ensure it is still performing as originally designed.

Cost: Registration fees range from $1,500 to $10,000 depending on the size and type of the project. Additional certification fees are assessed on a per square footage basis that ranges from $0.42/sf - $0.58/sf for new and existing buildings or interiors. The complexity of this process often requires an external consultant.

Fitwel

First created in 2017 by the US Center for Disease Control and Prevention (CDC) and the General Services Administration (GSA) and operated by the Center for Active Design. Fitwel was designed for commercial interiors, multi-tenant, and single-tenant buildings and encourages certification without necessarily engaging a consultant. It spans twelve sections: location, building access, outdoor spaces, entrances and ground floor, stairwells, indoor environment, workspaces, shared spaces, water supply, cafeterias, and prepared food retail, vending machines, and snack bars, and emergency procedures. This system allows for more simple and flexible compliance paths in comparison to the WELL building standard.

Cost: $500 project registration and $6,000 certification cost per project.

3.2 Healthy Building Features

The features of a Healthy Building are an extension of the features of a Green Building, additionally taking a more cohesive approach towards the design of the building to encourage more occupancy activity. Across the leading certification agencies, we have found several common features that are considered best practices in guiding the built environment towards healthy building standards: ergonomic furnishings, natural daylight, operable shading, natural views, green purchasing policies, zero asbestos,

	WELL	FITWEL
Description	Well Building Standard is modeled closely to LEED, but focused exclusively on impacts to human health and wellbeing.	Fitwel was designed for commercial interiors, multi-tenant, and single-tenant buildings and encourages certification without engaging a consultant.
Project Types	• WELL Certification • WELL Core • WELL Community Standard	• Multi-Tenant Base Building • Multi-Tenant Whole Building • Single-Tenant Building • Commercial Interior Space • Multi-Family Residential
Certification Level	Silver Gold Premium	1 - Star 2 - Star 3 - Star
Registration & Certification Cost	Registration fees range from $1,500 to $10,000 depending on the size and type of the project.	$500 project registration and $6,000 certification cost per project.
3rd Party Certified	Yes	Yes
Prerequisites	Project must meet all preconditions for any certification level	None
Recertification	Every 3 years	Every 3 years
Verification	Documentation, on-site assessment, and performance testing	Documentation

Table 3-2 Fitwel vs WELL standard

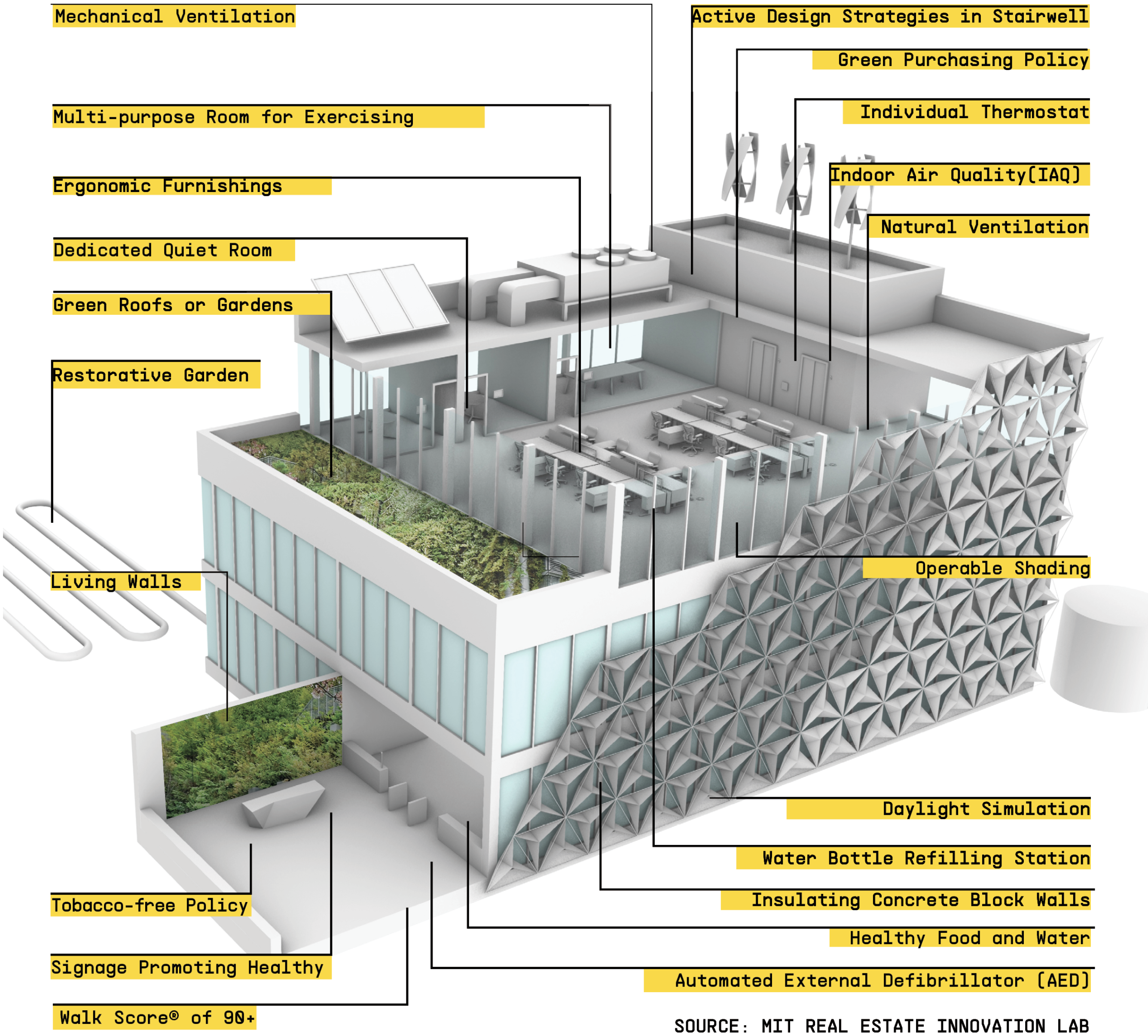


Figure 3-1 Technology and Design Features of Healthy Buildings (MIT REI LAB, 2020)

fitness rooms, indoor air quality (IAQ), and no-smoking policy.

These features indicate that in addition to traditional healthy air and light qualities, organizations are now pushing harder to encourage different ways of occupancy activity. Figure 4-1 displays additional common features.

In doing a deeper dive into the top healthy building features, we find research indicating value in either productivity or financial value.

Daylighting

Productivity

The presence of natural light in indoor spaces improves human health, well-being, and productivity. Workers in windowless environments reported poorer scores than their counterparts, as well as poorer overall sleep quality compared (Boubekri et al., 2014; Petrullo et al., 2016b).

Economic Value

Research looking at daylighting variances in New York City have found that high levels of daylight have a 5-6% rent premium over spaces with low levels of daylight (Turan et al., 2020a).

Related Top Healthy Building Features: Natural views, natural daylight

Greenery / Living Walls / Frontscapes

Productivity

Urban, street-level greenery and biophilia in the office are empirically documented to improve mental and physical health, increase productivity and urban environmental equality, and reduce carbon footprints (Ambrey & Fleming, 2014; Arvanitidis et al., 2009; Aydogan & Cerone, 2020).

Economic Value

Research looking at street-front greenery in New York City through a novel Green View Index (GVI) finds 8.9% to 10.5% statistically, economically, and positive transaction premium. Also, they found a 5.6% to 7.8% rent premium for offices with low to high street-level greenness relative to those building transactions correlated with very low greenness (Yang et al., 2020).

Related Top Healthy Building Features: Greenwalls, biophilia

Air Quality / Natural Ventilation

Productivity

Exposure to poor environmental conditions has been associated with deterioration of physical and mental health and with a reduction of cognitive performance (William J. Fisk, 1997; Künn et al., 2019; Wargocki, 1999b; Wyon, 2004).

Economic Value

The benefits of higher ventilation rates alone are estimated at $6,500 to $7,500 per person per year in employee productivity (MacNaughton et al., 2015a).

Related Top Healthy Building Features: Indoor air quality (IAQ), tobacco-free policy, no asbestos

Walkability

Productivity

Walkable places are streets and districts with physical attributes that encourage walking for functional and recreational purposes. Researchers have suggested that walkable places may produce a variety of environmental and social benefits – including less air pollution and car-use. Socially, it includes greater physical activity, increased social capital including more community cohesion, trust, and social activity (Foran & Saiz, 2017; Gilderbloom et al., 2015; Kim & Woo, 2016; Li et al., 2015; Towne et al., 2016).

Economic Value

The effects of walkability on property values and investment returns were found to capitalize on higher office, retail, and apartment values. On a 100-point scale, a 10-point increase in walkability increased values by 1-9%, depending on the property type. Research also found that walkability was associated with lower cap rates and higher incomes, suggesting it has become favored in both the capital asset and building space markets (Pivo & Fisher, 2011).

Related Top Healthy Building Features: Walk score, active design strategies in the stairwell

Ergonomics

Productivity

Office ergonomics is widely understood to result in a positive experience for employee health, performance, and satisfaction (Hedge & Dorsey, 2013; Lamb & Kwok, 2016).

Economic Value

Research has found significant decreases in the prevalence and total medical cost of injuries resulting from seated office work when incorporating ergonomic furnishings. On average, there were fewer medical paid costs per claim, less time loss days by the employee, and less medical claims overall (Brace, 2005).

Related Top Healthy Building Features: Ergonomic furnishings

Chapter 04

Valuations in the Top United States Office Markets

4.1 Methods for Pricing Commercial Real Estate

Methods for pricing commercial real estate are commonly based on a market comparables approach and a cap rate approach. However, despite the popularity of using these methods, there are still some drawbacks.

These methods are prone to inflation or deflation of pricing based on how the market is performing, although the underlying building asset has not changed. In this case, the market value of an asset does not equate to its intrinsic value . Investors then look to value properties based on a benchmark. The NCREIF Property Index (NPI) was the first property index introduced in the late 1970s, measuring the historical performance of income-producing commercial properties. Presently, the NPI includes over 7,000 properties worth over $350 billion.

Despite this, private real estate still lacks a comprehensive benchmark that can mirror the increasingly wider range of investment strategies due to inherent challenges in the industry:

(1) an index should be "passive", but real estate assets are often changing due to capital expenditures and tenant improvements that change the underlying asset,

(2) An index needs to be informationally efficient, but the real estate industry is infamous for the needing local knowledge,

(3) real estate does not have daily liquidity similar to stocks as most transactions occur privately and infrequently, making it difficult to access instant valuations (Mueller et al., 2014). These three character-

istics make it extremely challenging for the private real estate industry to create a true index for comparative needs. Also, these property indexes often experience appraisal-smoothing and temporal lag bias (Geltner, 2007b).

While appraisal-based indexes have been the only available indexes until recently and serve as a good base, research shows that the addition of direct transaction price evidence from the property market (Geltner, 2007a) can help strengthen appraisals since it is these transaction prices that most reflect the actual experiences of real estate investors. Some of the large transaction-based databases that have come about at the turn of the century are CoStar Commercial Repeat-Sales Index (CCRSI), Moody's/REAL Commercial Property Price Index (CPPI), Real Capital Analytics (RCA) in the US; and Investment Property Databank (IPD) in the United Kingdom.

4.2 Hedonic Technique: Transaction-Based Methodology

Within transaction-based indexes, there is hedonic indexing, based on hedonic price modeling, which controls for heterogeneity by modeling property assets as bundles of characteristics or hedonic variables (Geltner, 1993). With a hedonic model, an appraiser can regress prices without the need for repeat sales history. It can also determine the correlation between the transaction price and building characteristics, such as location, time, age, renovation date, and internal design features. By extension, this can also determine which building characteristics add value to the potential transaction price since it controls for all other characteristics (A. M. Chegut et al., 2013).

However, the hedonic technique has its limitations as the model is only as strong as the data provided and its building characteristics (spatial and physical) need to be fully captured.

Chapter 05

Data Collection and Descriptive Statistics

In this chapter, we discuss the steps taken to perform a regression on healthy-certified buildings.

5.1 Data Sources

In this study, we use four main data sources. The first is CompStak commercial real estate data. CompStak data was shared with the MIT Real Estate Innovation Lab (REIL) and has had data agreements signed. The other two data sources are health-certification organizations, Fitwel, and WELL. The last is the Green Building Information Gateway (GBIG) that lists LEED information.

CompStak

CompStak creates transparency in commercial real estate markets by gathering information that is hard to find, difficult to compile, or otherwise unavailable. Since 2012, CompStak has delivered this unmatched insight to a network of tens of thousands of members and clients, including Tishman Speyer, Wells Fargo, Vornado, Boston Properties, Equity Office Properties, and every major brokerage nationwide. CompStak Exchange is an exclusive platform for CRE brokers, appraisers, and researchers to get analyst-reviewed commercial lease and sales comparables (comp) at no charge (CompStak 2020).

CompStak provides verified, real-time information by:

- Machine Learning: A statistical anomaly detection system and machine learning algorithms identify outlier lease data for in-depth review. Each comp in the database has received an average of five times which allows the system to refine their information.
- Analyst Review: A dedicated team of real estate analysts and data scientists investigate and correct comp anomalies to further ensure accuracy. This includes cross-checking lease details across multiple submissions, researching the market, and manually verifying with brokers as needed.
- Community Regulation: Pre-screened and trusted CRE professionals make up a crowd-sourced community who provides accurate lease information.

Fitwel and WELL

Both Fitwel and WELL lists publically available addresses that provide information on the level of health certification, certification rate, street address information.

Green Building Information Gateway (GBIG)
The GBIG database was created by the US Green Building Council and lists LEED-certified projects around the world.

5.2 Variable Selection

This study focused on the office market in the top ten cities and does not take into account other sections of real estate (residential, retail, hospitality, etc). We then keep attributes that affect the effective rent calculated.

CompStak attributes include:

Effective Rent (USD)
Building Floors
Transaction Quarter
Commencement Date
Transaction Square footage
Year Built
Year Renovated
Building Class
Submarket
Execution Date
Lease Term
Total Transaction Size
Transaction Type
Free Rent
Street Address
Zipcode
Work Value (USD)

Healthy attributes include:

Fitwel Healthy Star Rating
WELL Version
Healthy Building

Healthy Certification Date
Fitwel certified
WELL certified

Green attributes include:

LEED
LEED Points Achieved
LEED Type

	City	# Of Healthy Projects	# of Healthy Rental Contracts	# of Rental Contracts Total	Earliest Certification Date
1	Atlanta	23	35	218	9/1/2017
2	Boston	29	179	851	6/27/2017
3	Chicago	38	343	1662	10/11/2016
4	Denver	18	56	216	1/29/2018
5	Los Angeles	37	285	739	9/22/2016
6	New York	128	992	5718	11/8/2016
7	Philadelphia	14	37	78	11/1/2018
8	San Francisco	59	249	2163	11/8/2016
9	Seattle	20	43	109	12/21/2018
10	Washington DC	41	103	1395	6/9/2017
	Subtotal	**407**	**2322**	**13149**	
	Total		15471		

Table 5-1 Fitwel and WELL Certified Projects

5.3 Methodology

To establish a methodology, we look at precedence set by "Doing Well by Doing Good? Green Office Buildings" (Eichholtz et al., 2010). In this research paper, Piet Eiccholtz, Nils Kok, and John M. Quigley provide a systematic analysis of the impact of environmentally sustainable building practices upon the financial returns as measured by the marketplace. From here, our research paper implements a similar methodology:

1. Collect publicly available addresses from WELL and Fitwel which results in [755] office projects spanning the United States. Figure [6-1] provides a geographic summary of our matches. A closer look at the data finds that healthy buildings represent [2.79]% of the current contract sample, with the top three major cities in New York, San Francisco, and Washington D.C. leading the way at [56]%.

2. From here, we identify the top 10 healthy-building cities, resulting in [407] projects spanning Atlanta, Boston, Chicago, Denver, Los Angeles, New York, Philadelphia, San Francisco, Seattle, and Washington D.C.

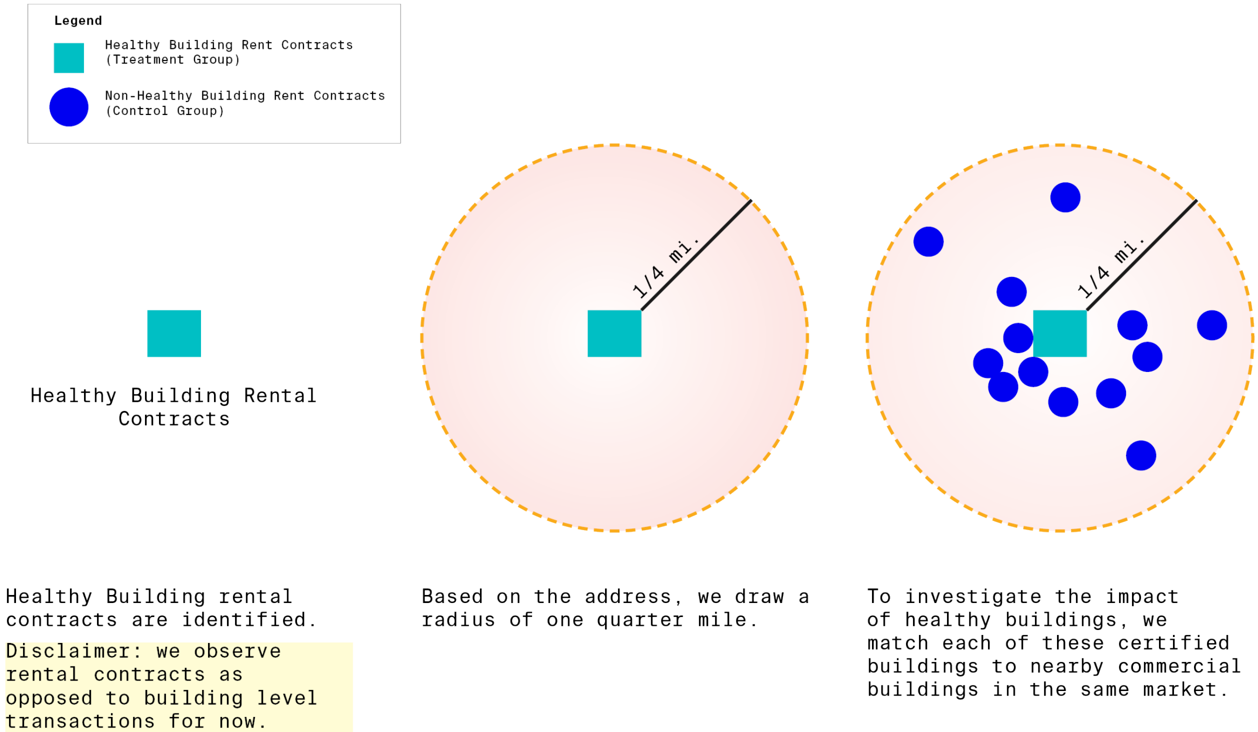


Figure 5-1 Healthy Building Identification Strategy

Our identification strategy seeks a rigorous matching strategy for the time and location of the healthy building experience.

3. We then extract CompStak rental contract data points in each of the ten cities from the earliest certification date, resulting in [45,733] data points.

4. To investigate the impact of healthy buildings, we match each of these certified buildings to nearby commercial buildings in the same market to ensure neighborhood quality controls, similar to Kok et al., (2010)'s Doing Well by Doing Good.

5. Based on the address, we draw a radius of one-quarter mile. Refer to Figure 6-1.

6. From here, we created clusters of nearby office buildings with rental contracts. Each small cluster contains one certified building and at least one non-rated nearby building with a rental contract within. The total sample of non-certified buildings contains [13,148] control buildings with rental data.

7. We then extract LEED information from the Green Building Information Gateway (GBIG) on each of the contract data points to match whether or not any of the contracts are also a green building.

Descriptive Statistics	(a) Healthy Building Descriptives					(b) Control Descriptives				
Statistic	N	Mean	St. Dev.	Min	Max	N	Mean	St. Dev.	Min	Max
Fitwel	2,322	0.6	0.5	0	1	13,148	0.0	0.0	0	0
Well	2,322	0.4	0.5	0	1	13,148	0.0	0.0	0	0
Effective Rent (per Year)	2,322	56.4	29.4	1.2	246.6	13,148	53.5	23.7	1.2	448.8
Logged Effective Rent	2,322	3.9	0.6	0.2	5.5	13,148	3.9	0.5	0.2	6.1
Transaction Squarefoot	2,322	24,744.6	56,922.6	227	1,463,234	13,148	16,033.3	41,389.8	60	1,122,702
Year Built	2,322	1,967.9	28.2	1,895	2,019	13,148	1,957.7	33.0	1,765	2,020
Builidng Age	2,322	50.0	28.1	-2	124	13,148	60.1	32.9	-3	254
Year Renovated	2,322	1,527.1	856.1	0	2,019	13,148	1,280.3	961.6	0	2,019
Renovated Building (Yes=1)	2,322	0.8	0.4	0	1	13,148	0.6	0.5	0	1
Commencement Year	2,322	2,017.8	1.2	2,016	2,020	13,148	2,017.8	1.1	2,016	2,020
Building Class A (Yes=1)	2,322	0.9	0.3	0	1	13,148	0.6	0.5	0	1
Building Class B (Yes=1)	2,322	0.1	0.3	0	1	13,148	0.3	0.5	0	1
Building Class C (Yes=1)	2,322	0.001	0.03	0	1	13,148	0.03	0.2	0	1
Tenant Broker (Yes=1)	2,322	0.3	0.4	0	1	13,148	0.2	0.4	0	1
Landlord Broker (Yes=1)	2,322	0.3	0.5	0	1	13,148	0.2	0.4	0	1
Lease Term (in months)	2,322	88.3	50.2	0	368	13,148	75.3	45.2	0	396
Free Rent (in months)	2,322	4.5	4.7	0	36	13,148	3.6	4.3	0	50
Work Type: As Is (Yes=1)	2,322	0.1	0.3	0	1	13,148	0.1	0.3	0	1
Work Type: Tenant Improv (Yes=1)	2,322	0.7	0.5	0	1	13,148	0.6	0.5	0	1
Work Type: Built to Suit (Yes=1)	2,322	0.002	0.04	0	1	13,148	0.002	0.04	0	1
Work Type: Paint and Carpet (Yes=1)	2,322	0.003	0.1	0	1	13,148	0.005	0.1	0	1
Work Type: Pre Built (Yes=1)	2,322	0.03	0.2	0	1	13,148	0.02	0.1	0	1
Work Type: Turn Key (Yes=1)	2,322	0.02	0.1	0	1	13,148	0.03	0.2	0	1
Work Type: Other (Yes=1)	2,322	0.0	0.0	0	0	13,148	0.000	0.02	0	1
Work Type: Spec Suit (Yes=1)	2,322	0.01	0.1	0	1	13,148	0.01	0.1	0	1
Work Type: Workletter (Yes=1)	2,322	0.0	0.0	0	0	13,148	0.001	0.02	0	1
Work Type: Not Specified (Yes=1)	2,322	0.0	0.0	0	0	13,148	0.0	0.0	0	0
Transaction Type: Expansion (Yes=1)	2,322	0.1	0.3	0	1	13,148	0.1	0.3	0	1
Transaction Type: New Lease (Yes=1)	2,322	0.5	0.5	0	1	13,148	0.5	0.5	0	1
Transaction Type: Extension(Yes=1)	2,322	0.03	0.2	0	1	13,148	0.03	0.2	0	1
Transaction Type: Renewal (Yes=1)	2,322	0.2	0.4	0	1	13,148	0.2	0.4	0	1
Transaction Type: NA (Yes=1)	2,322	0.0	0.0	0	0	13,148	0.0	0.0	0	0

Table 5-2 Descriptive Statistics (Contract Analysis)

5.4 Descriptive Statistics

Our contract sample contains 15,470 observations from which 2,322 are health-registered or health-certified, and 13,148 observations are considered non-healthy (control group). We use three data sources. We first use Compstak's transaction database from 2016 to 2020 as our base data source for both the treated and control group. This is to account for the earliest certification date in each city: Atlanta, Boston, Chicago, Denver, Los Angeles, New York, Philadelphia, San Francisco, Seattle, and Washington, DC.

The database provides information for each lease transaction including tenant name, landlord brokerage firm, building age, broker, lease length, location, effective rent, tenant improvement allocations, etc.

We then use Fitwel and WELL's publically available database for the ten cities to identify the treated sample of healthy buildings and their leases. We use building address, city, and zip code to identify the treated healthy

Figure 5-2 Certified and Registered Healthy Contract Locations and nearby control contract locations

spaces and match to their corresponding leases in the Compstak database.

Finally, we do the same matching of address, city, and zipcode to the Green Building Information Database (GBIG) to indicate spaces that are also LEED-certified, and thus, considered a green building.

The healthy database contains only the healthy certification date, the healthy version was used for the analysis. As for the Compstak database, it is comprised of 76 variables including an effective rent variable for each lease. From this Compstak set, 14 variables were deemed to be relevant for this study. These 14 variables belong to categories related to market, building, tenant, and lease characteristics.

5.4.1 Dependent Variable

Effective Rent

We analyze the sample set for the logged effective rents for the lases. Out of 13,148 non-treated observations, we found an average effective rent of $53.50 psf with a standard deviation of $23.70 psf. The lowest effective rent was $1.20 psf and the maximum was $448.80 psf. Out of the 2,322 healthy observations, we had an average of $56.40 psf with a standard deviation of $29.40. The lowest effective rent was $1.20 psf and the maximum was $246.60 psf.

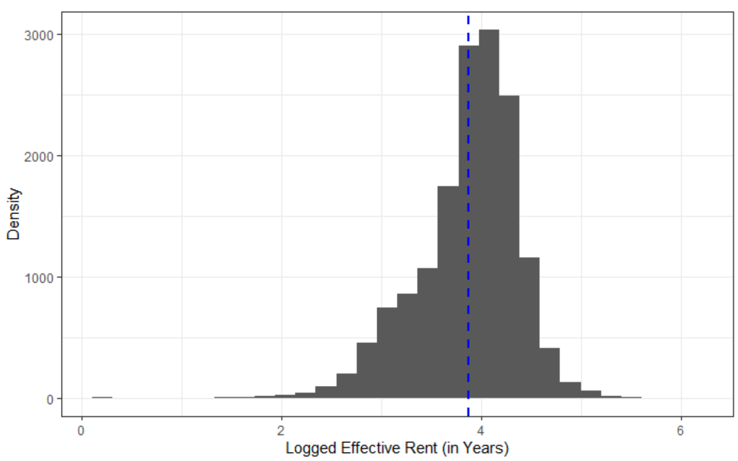


Figure 5-3 Logged Effective Rent (in Years)

5.4.2 Variable of Interest

Healthy-Contract

We have 2,322 healthy contracts that are made up of either Fitwel or WELL registered and certified projects.

5.4.3 Market Characteristics

The study considered two market-related variables – location and lease commencement date. These two variables were deemed to have a critical influence on effective rents.

Table 5-3 Sample by Building Class and City

Location/ Sub Market

We look at submarkets in the top ten cities that have healthy contracts: Atlanta, Boston, Chicago, Denver, Los Angeles, New York, Philadelphia, San Francisco, Seattle, and Washington DC. Healthy buildings tend to congregate in city central business districts. Refer to Figure 6-3.

5.4.4 Building Characteristics

The study looks at how the physical characteristics of buildings can affect the leased space.

Year Built / Building Age

In looking at building age, we find an average of 50 years old for healthy spaces and an average of 60 years old for non-healthy controlled spaces.

Year Renovated / Renovated Building

We also found it important to look at whether or not the spaces have been renovated. In looking between healthy spaces and non-healthy spaces, healthy buildings have a higher chance of renovated spaces.

Building Class

Healthy spaces tend to occupy a Class A building. Table 6-4 reflects the comparison between healthy and non-healthy spaces in each city, divided by Building Class A, B, and C. (Table 6-4)

5.4.5 Lease Characteristics

Lease Term in Months

For the non-healthy, controlled spaces, the average lease term was 75.3 months, with a standard deviation of 45.2 months. The maximum lease term was 396 months. In comparison, healthy spaces had an average lease term of 88.3 months with a standard deviation of 50.2 months. The maximum lease term was 368 months.

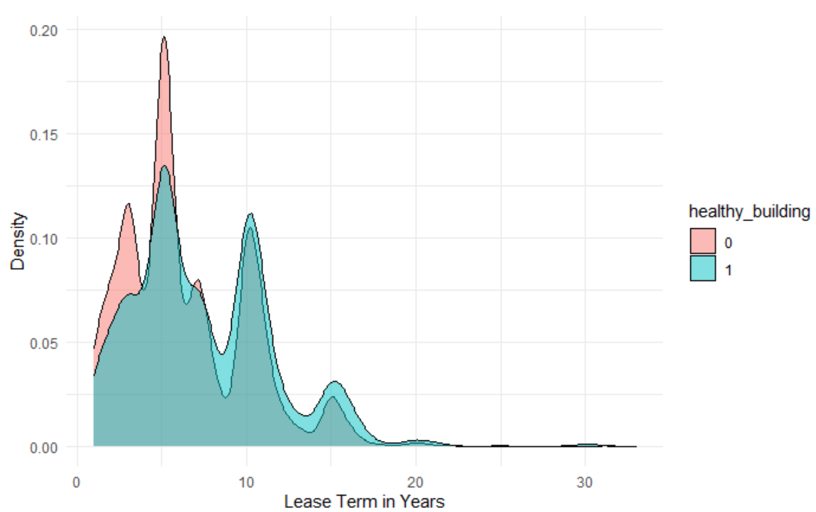


Figure 5-4 Lease Term in Months (Healthy Building vs Control)

Free Rent in Months

For non-healthy controlled spaces, the average free rent given in months was 3.6 months with a standard deviation of 4.3 months. The maximum free rent given was 50 months. In comparison, healthy spaces had an average of 4.5 months worth of free-rent, with a standard deviation of 4.7 months. Here, the maximum months of free rent given were 36 months.

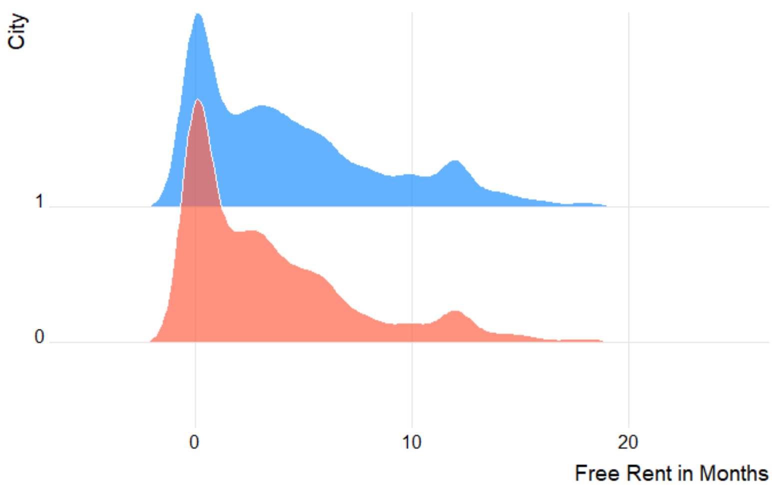


Figure 5-5 Free Rent in Months (Healthy Building vs Control)

Work Type

This study looks at 10 different work-types: As-Is, Tenant Improvement, Build to Suit, Paint and Carpet, Pre Built, Turn Key, Other, Spec Suite, Work letter, and Unspecified. In looking at the full sample, we see that a majority of the lease types are Tenant Improvement, followed by Turnkey spaces. Healthy spaces are pre-dominantly tenant-improvement spaces.

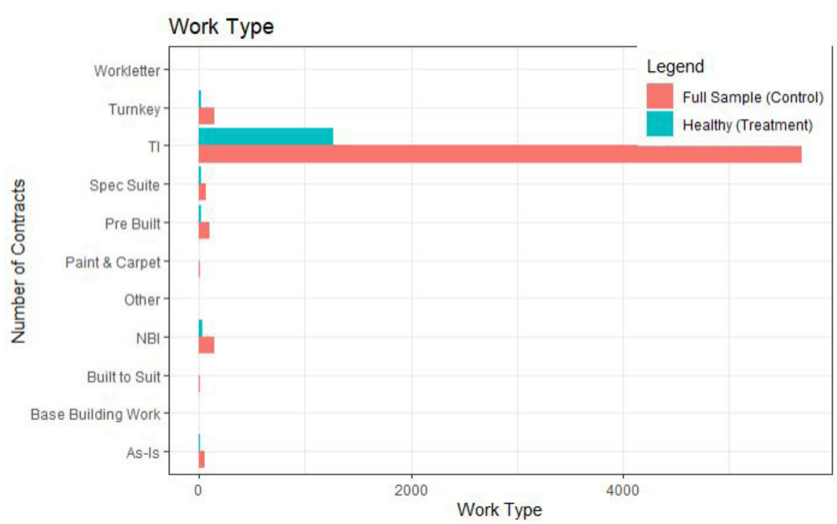


Figure 5-6 Work Type (Healthy Building vs Control)

Transaction Type

We look at 12 different types of transactions, Restructure, Renewal/Expansion, Renewal/Contraction, Renewal, Relet, Pre-lease, New Lease, Extension/Expansion, Extension, Expansion, Early Renewal, and Unknown. The full sample tends to have new lease transaction types, followed by renewal, and expansion. Healthy spaces tend to also be new leases, followed by renewal, and expansion.

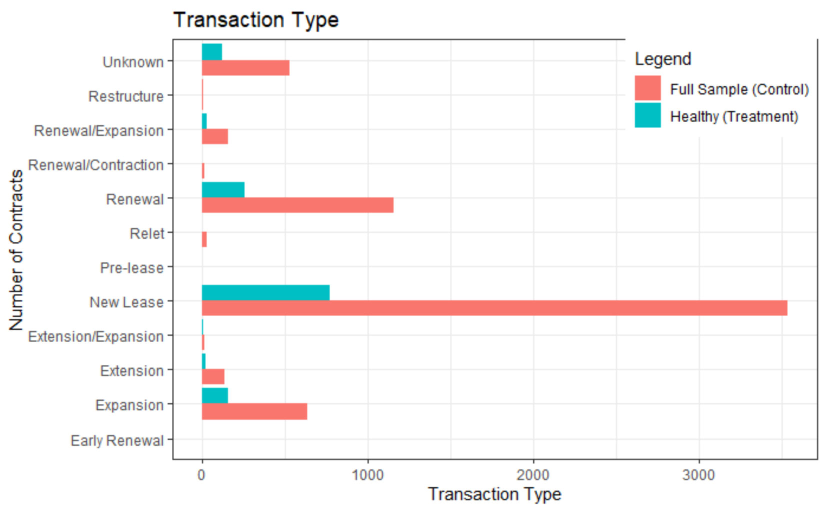


Figure 5-7 Transaction Type (Healthy Building vs Control)

Transaction Squarefootage

Non-healthy spaces seen an average lease of 16,033 square footage, with a standard deviation of 41,398 SF. The maximum square footage is 1,122,702 SF. Healthy spaces have an average of 24,744 SF, with a standard deviation of 56,922 SF. The maximum square footage of healthy spaces is 1,463,234 SF.

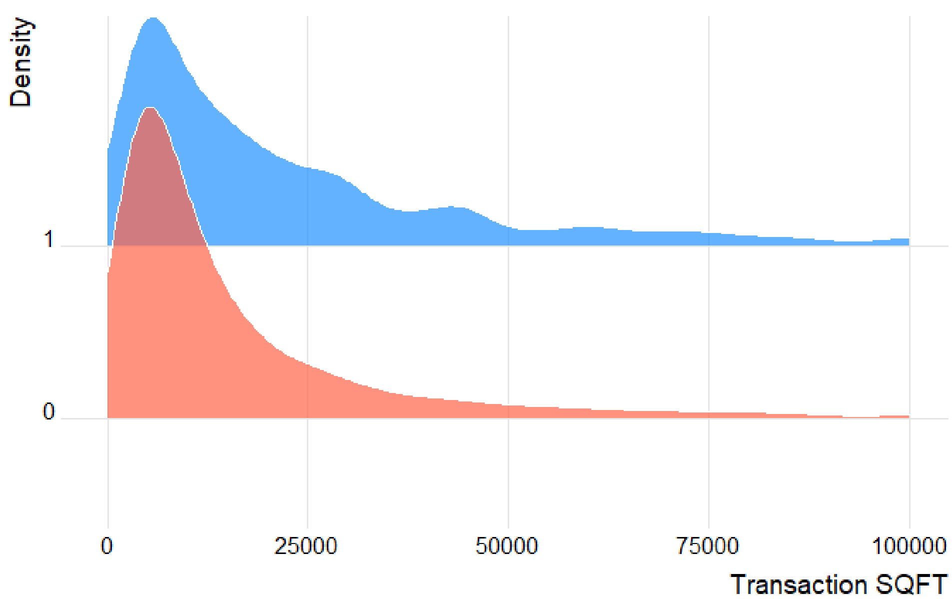


Figure 5-8 Transaction Square Footage (Healthy Building vs Control)

Chapter 06

Methodology

6.1 Hypothesis

Healthy Buildings poses an interesting financial puzzle - are they seen as equal asset types, a delivery failure, or the key to a healthy employee or tenant?

What could positive, negative, or equal effective rents between certified and non-certified spaces mean? Figure 7-1 reflects the potential implications of Healthy Buildings.

Equal

If building owners perceive healthy buildings as equal to other assets, this suggests that tenants do not ascribe economic value to occupying health certified space, or at least are not willing to adjust their rent in light of a certification.

NO VALUE (EQUIVALENT)
Result: equal

Healthy Buildings are seen as a non-differentiator in the marketplace.

DELIVERY FAILURE (DOWNSIDE)
Result: negative

Healthy Buildings are not delivering what they promised.

HEALTHY EMPLOYEE (UPSIDE)
Result: positive

Healthy Buildings are seen as an asset that improve employee or tenant well being and productivity.

Figure 6-1 Potential Implications of Healthy Buildings

Negative
If building owners perceive healthy buildings as negative, this would suggest that the spaces do not provide the benefits promised by the certification

Positive
If building owners perceive healthy buildings as positive, this would suggest that tenants see value in occupying healthy space and preserving their employee's health and will pay a premium to do so.

6.2 Model

In this research paper, we employ a hedonic pricing model (Rosen, 1974), which assumes that individual, observable building characteristics can independently add up to the overall price of a building – whether or not it be rental or transaction pricing. It does this by measuring the weighted values of differing observable characteristics of a building spanning physical, temporal, and special qualities.

Equation 7-2 presents the functional form of the vectorized hedonic model specification:

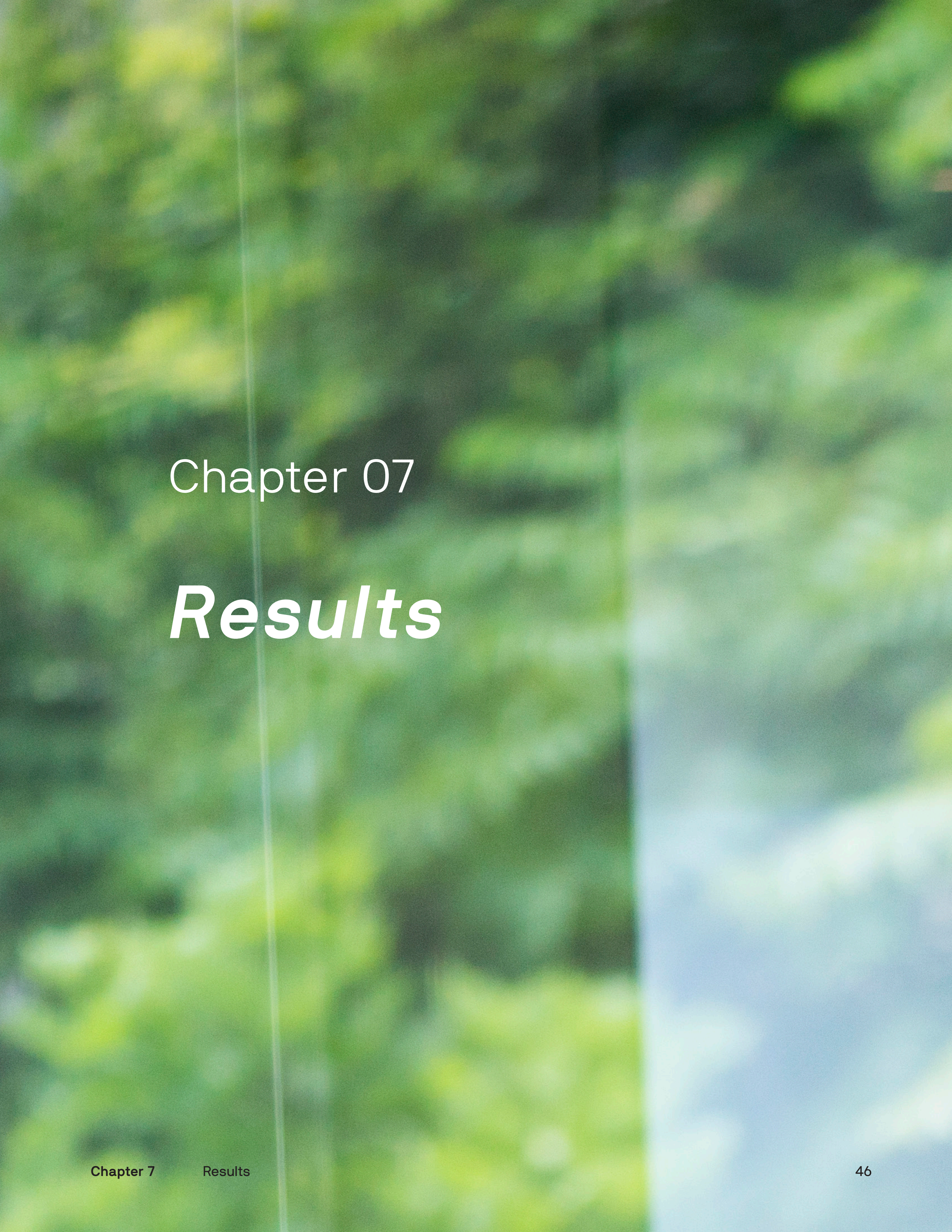
Where the dependent variable logP is the logarithm of the realized net effective rent per square foot for rental contract observation (i). We observe individual lease contracts over the earliest certification date by market.

(Z) is the variable of interest, representing if space is healthy (designated as healthy = 1) for rental contract observations (i). (T) is a vector of exogenous location fixed effects by sub-market (such as East Cambridge, CBD River North, Jackson Square, Mid Wilshire). (R) is a vector of time fixed effects by quarter and year that the lease is executed. (S) is a vector of exogenous hedonic building characteristics (age, building class, renovated, work type, transaction type, LEED) of the building in which the rental contract observation (i) is located. (L) is a vector of the lease contract terms (lease duration, tenant improvement costs, etc) for rental contract observation (i).

δ, β, θ, μ, and Φ is the estimated parameter vectors, representing the functional relationship between each independent variable and the dependent variable. ε is the error term, a vector of independent, identically distributed regression disturbances.

$$logP_i = \alpha + \phi Z_i + \theta T_i + \delta R_i + \beta S_i + \varepsilon$$

Equation 6-1 Model Equation



Chapter 07

Results

To estimate the value of healthy, we operationalize a hedonic model that takes into account all the different variables that make up a building's value through their individual building and neighborhood characteristics. In this case, the effective rent price is a measure of value that a tenant is willing to exchange for a bundle of characteristics they would like to lease. In this chapter, we discuss the results of our analysis and explore the statistical and economic significance of healthy spaces.

Table 7-1 presents the regression results previously specified in Equation 4-1. These results account for the lease samples, relating the logarithm of effective rent per square foot of commercial office space to a set of hedonic characteristics, tenant industry type, and lease contract features. These hedonic specifications explain over sixty-five percent of the variation in the logarithm of effective rents per net square feet with an adjusted R-squared ranging from 65% to 69%.

The four columns in Table 7-1 present the incremental development of the multiple linear regression model. In each column, a new set of variables are added in the following order: location fixed effects, time fixed effects, building characteristics, lease contract terms, and interaction effects. By building the regression effects incrementally, we operationalize Equation 4-1 by identifying how the variables start to interact with each other and how they impact the overall model fit.

In column (1), we add the variable of interest, healthy contracts, a LEED identifier, and a neighborhood categorical variable to the model. For this specification, the model explains approximately 65% of the variation of effective rent per square foot.

In column (2), we add controls for time-fixed effects in the form of transaction quarter categorical variable. For this specification, the model explains approximately 66% of the variation of effective rent per square foot. The results indicate a positive increase in quarter over quarter. We find a dip in the rent premium between 2016 and 2018. Post-2018, we see an increase in effective rent, quarter over quarter.

In column (3), we add controls for building characteristics including building class type, building age, and an indication for renovated buildings. We find that buildings with Class A and B command the highest premium, at 19.6% and 11.9% respectively. Renovated buildings reflect a premium of only 2.2%.

In column (4), we add controls for lease contract characteristics including lease term in months, free rent in months, work type, landlord and broker factors, and transaction type. We find that compared to unspecified work type contracts, pre-built spaces command an 8.9% premium in effective rents. Also, compared to renewal transaction types, spaces that are new leases hold a 4.4% premium.

Table 7-1 The Impact of Healthy Contracts on Logged Effective Rents

	Dependent Variable			
	Effective Rent per Sqft			
	(1)	(2)	(3)	(4)
Variable of Interest				
Healthy Contract (Certified=1)	0.070***	0.069***	0.051***	0.044***
	(0.007)	(0.007)	(0.007)	(0.007)
LEED (Yes=1)	0.028***	0.024***	-0.008	-0.003
	(0.006)	(0.006)	(0.006)	(0.006)
Building Classes (Base Case: Class C)				
Building Class A (Yes=1)			0.196***	0.218***
			(0.017)	(0.016)
Building Class B (Yes=1)			0.119***	0.132***
			(0.015)	(0.015)
Building Age			-0.001***	-0.001***
			(0.0001)	(0.0001)
Renovated Building (Yes=1)			0.022***	0.026***
			(0.006)	(0.005)
Lease Term (in Months)				0.002***
				(0.0001)
Free Rent (in Months)				-0.010***
				(0.001)
Work Type (Base: Not Specified)				
Work Type: As-Is (Yes=1)				-0.040***
				(0.009)
Work Type: Tenant Improvement (Yes=1)				-0.076***
				(0.006)

Work Type: Build to Suit (Yes=1)				-0.001
				(0.050)
Work Type: New Building install (Yes=1)				0.054***
				(0.016)
Work Type: Paint Carpet (Yes=1)				-0.036
				(0.033)
Work Type: Pre Built (Yes=1)				0.089***
				(0.018)
Work Type: Turnkey (Yes=1)				0.057***
				(0.015)
Work Type: Other (Yes=1)				-0.167
				(0.158)
Work Type: Spec Suite (Yes=1)				0.055**
				(0.024)
Work Type: Workletter (Yes=1)				-0.056
				(0.104)
Tenant Broker (Yes=1)				-0.002
				(0.006)
Landlord Broker (Yes=1)				0.021***
				(0.006)
Transaction Type (Base: Renewal)				
Transaction Type: Expansion (Yes=1)				0.021**
				(0.009)
Transaction Type: New Lease (Yes=1)				-0.011*
				(0.006)
Transaction Type: Extension (Yes=1)				0.043***
				(0.014)
Transaction Type: NA (Yes=1)				0.044***
				(0.007)
Logged Transaction Square footage				-0.019***
				(0.002)
Constant	3.776***	3.757***	3.597***	3.679***
	(0.009)	(0.092)	(0.092)	(0.091)
Observations	15,470	15,470	15,470	15,470
R^2	0.655	0.666	0.676	0.699
Adjusted R^2	0.654	0.664	0.674	0.697
Residual Std. Error	0.292 (df = 15401)	0.288 (df = 15383)	0.284 (df = 15379)	0.274 (df = 15360)
F Statistic	430.307*** (df = 68; 15401)	356.593*** (df = 86; 15383)	355.816*** (df = 90; 15379)	327.237*** (df = 109; 15360)

*Note: The dependent variable is the logarithm of effective rent per square feet. Standard errors are in paratheses. All models include submarket fixed effects to control for location, and time-fixed effects through the transaction quarter to control for time-variation in rental prices. *, **, *** denotes significance.*

Chapter 08

Discussion and Conclusion

8.1 Discussion & Conclusion

Our buildings are increasingly becoming more than just physical shelters, they feed into our everyday health and wellbeing. Companies are now, more than ever, taking a holistic approach towards real estate through the incorporation of a wide range of design strategies that focus not only on employee productivity but also on employee health and wellbeing. A team from Maastricht University recently demonstrated that a healthier building, on average, leads to a healthier employee and lower absenteeism (Palacios et al., 2020), linking indoor climate quality and an office user's health, well-being, job satisfaction, and productivity. While there has not yet been research on the economic impacts of healthy buildings, there has been substantive research done in investigating separate features of healthy buildings (daylight, ergonomic furnishings, indoor air quality, biophilia/green frontage, etc). All of which points to value, both in productivity and financially. Our research work confirms that there is a financial premium for facilitating these healthier spaces.

We find that healthy building effective rents transact between 4.4 and 7.7% more per square foot than their nearby unhealthy neighbor peers. In other words, if a non-healthy space transacts at $50 per square foot, the same space with healthy certification would expect to transact at an added 4.4% or $52.20 per square foot. This premium for healthy spaces is independent of all other factors, such as LEED certification, building age, renovation, lease duration, and submarket. This financial premium for healthy spaces indicates that healthy buildings are seen as an asset that improves employees well-being and productivity.

Healthy spaces and the corresponding design interventions that are associated with them are often the first items to be value-engineered in comparison to more efficient building designs that prioritize cost. The real estate industry is inherently risk-averse and because of it, adopt changes slowly (Kelly, n.d.).

This is why, traditionally, qualitative design features need to go through the process of analyzing the financial impact, especially those that are seen as new and innovative to quicken the adoption rate. If an owner or developer can recognize a healthy space's value both economically and socially, they will be better incentivized to under-write it into their financial models and move forward with implementation. Similarly, recognizing the market value of healthy spaces will help governments and planning agencies make the case for adding healthy components to all spaces as municipal-level initiatives.

Our research shows that Green Buildings have set precedence for Healthy Buildings in more ways than one– many states and cities have already adopted Green Building regulatory requirements as policy instruments which, in turn, have played a strong role in promoting green office building designations (Choi, 2010) as well as improving overall energy consumption (Fellows, 2006; Pan et al., 2008; Rajgor, 2005), indoor air quality (Matela, 2006), occupant's satisfaction (Prasow, 2008), and property value (Dermisi, 2011; Fuerst & McAllister, 2008).

This paper's financial results point to similar outcomes in Green Building rental outcomes. Doing Well by Doing Good (Piet Eichholtz et al., n.d.) found comparable effective rents were 2.8% more per square foot. Besides that, we find that healthy buildings are gaining traction fast. Even without prior economic research on healthy building certification, this is in line with prevailing studies and value premiums shown in the individual features that make up a healthy building certification such as:

(1) good daylighting in NYC reflecting a 5-6% rent premium,

(2) street-front greenery in NYC found a 5.6% to 7.8% rent premium,

(3) benefits of higher ventilation rates estimated at $6,500 to $7,500 per person per year in employee productivity, and

(4) walkability scores increasing values by 1-9% (MacNaughton et al., 2015b; Pivo & Fisher, 2011; Turan et al., 2020b; Yang et al., 2020).

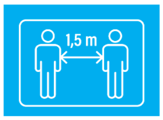
Relative to green building certification, there is double the adoption rate of these healthy spaces according to the internal data at the MIT Real Estate Innovation Lab. The results are also in line with observations from the lab that notice an increasing trend of design interventions such as Smart, Connected, Green buildings (A. Chegut et al., 2011; Keitaro et al., 2018; Turan et al., 2020a) commanding higher rents and transaction costs on average with longer lease terms.

Observational data like human decision making will always have bias and error. Potential sources of bias in this analysis could stem from omitted variable bias, where features of the individual tenants are unknown and may explain effective rents. Similarly, we do not have enough sample data to further look into the potential transaction cost impacts. Moreover, locational and time-period sampling may not be purely from a random sample. This is in turn only the first step in truly determining the economic and financial impact of Healthy Buildings.

In addition, this research explains 65-69% of the variation in effective rents per square foot. Roughly 30% of the price variation remains omitted or unexplained, but this model has a very high forecasting range. This might

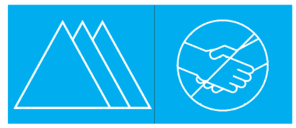
DESIGNING WITH DENSITY

Deliberately set aside a percentage of square footage to be experimental and prepared for learning what a new behavior needs to be.



TOUCHLESS WORKPLACE

Design interventions focused on viral transmission risk, including smart materials, pinch points, and voice activation.

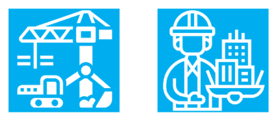


LOBBIES ARE PRE-CLEAN ROOMS

Sensors and other scanning technologies can also help reacclimate people to public gathering spaces.

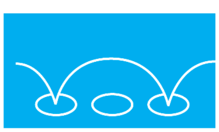
OFF-SITE CONSTRUCTION

Fabricating and assembling building components offsite could prove to be a healthier alternative to traditional construction.



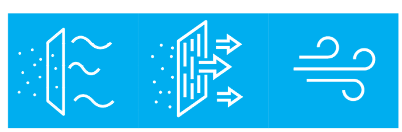
MIXED USE REAL ESTATE TO SUPPORT ORGANIC DENSITY

Self-sustaining districts and connected communities will experience a resurgence.



ACCESSIBLE OUTSIDE AIR FLOW

Fresh, clean air helps maintain healthier environments & dilutes the human-to-human passage of airborne elements.



Source: Gensler & Princeton University (Lewis and Nordenson)

Figure 8-1 Design Impacts Moving Forward (D. A. Chegut & Short, 2020) be due to real estate assets deriving value from other qualitative features that aren't observed in CompStak or other databases. This might include architectural quality, views, and other design interventions that do not get parsed out. There is now initial research into accounting for this portion to further evaluate the value of design in real estate asset pricing (Rong et al., n.d.).

Nevertheless, it is equally important to start verifying the positive implications of healthy spaces. Because healthy certification is based on design-metrics, it is important to re-assess and re-certify spaces every couple of years to ensure that they are performing at the level expected. To do this, owners must start to utilize the data information being collected by building sensors to better manage and act upon real-time sustainability data. In the past 5 years, there has been considerable movement in this field. In 2018, GRESB partnered with Measurabl to develop ESG data industry standards (GRESB, n.d.) to elevate and enable the use of sustainability data in any commercial real estate transaction.

To move forward with our research and truly understand what the economic impact is, we look to work with a full set of data with both public/private observations. We also look to account for construction costs to offset the potential increased costs in constructing and certifying these healthy buildings. However, here, we can take precedence work from Green Buildings that was able to utilize United Kingdom construction cost data (A. Chegut et al., 2019) to understand the initial hypothesis of where healthy buildings might land in terms of marginal cost. Understanding the impacts of cost and a more comprehensive data transaction sample size will help us further make a strong case for the benefits of building healthy spaces.

Preliminary design research predicts that owners will design and curate spaces with a different set of intentions that help people return to public spaces (Billington, 2020; Fullbright, 2020; Lewis, Paul, Nordenson, n.d.). These changes include designing for density, incorporating touchless design interventions, designing lobbies as pre-clean rooms, utilizing off-site construction, incorporating accessible outside airflow, and exploring mixed-use real estate to support organic density (Figure 8-2).

The COVID-19 pandemic makes this paper's findings particularly relevant for investors. The financial performance of healthy buildings that pay particular attention to the health and well-being of occupants is critical to our return to a "new normal" in the office environment where tenants and landlords will now discuss air quality as an equally important feature in their leases.

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