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EFFECTS OF WALKABILITY ON PROPERTY VALUES AND INVESTMENT RETURNS

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ABSTRACT

The purpose of this study was to examine the effects of walkability on property values and investment returns. Walkability is the degree to which an area within walking distance of a property encourages walking for recreational or functional purposes. It is of particular concern to developers, investors and others interested in sustainable and responsible property investing because of its potential social and environmental benefits. We used data from the National Council of Real Estate Investment Fiduciaries (NCREIF) and Walk Score to examine the effects of walkability on the market value and annual investment returns of nearly 11,000 office, apartment, retail and industrial properties over the past decade in the USA. We find that, all else being equal, the benefits of walkability are capitalized into office, retail, apartment and industrial property values with more walkable sites commanding higher property values. On a 100 point scale, a 10 point increase in walkability increases property values by 5 to 8 percent, depending on property type. We also find that walkability is associated with lower cap rates and higher incomes, suggesting that the higher values are caused by both higher incomes and expectations of less risk, greater income growth or slower depreciation. Walkability only had a positive effect on historical investment returns for offices. It negatively affected returns for retail and apartments and had no effect on industrial property. The negative effect on retail was mostly due to slower appreciation, suggesting the price premium may have been too high and was adjusting during the study period, so walkable retail could earn a market return going forward. For apartments the negative effect on total return was caused by lower income returns (lower cap rate), suggesting either that they were considered less risky, which could justify the lower total returns, or greater income and price appreciation was anticipated than materialized. All walkable property types generated higher income and therefore have the potential to generate returns as good as or better than less walkable properties, as long as they are priced correctly. Moreover, developers should be willing to develop more walkable properties as long as they do not have to pay too high a premium for more walkable locations and related development expenses.

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INTRODUCTION

The emerging field of Responsible Property Investing (RPI) is concerned with real estate investments that benefit both investors and the common good. It examines portfolio, asset and property management activities that go beyond compliance with minimum legal requirements to better manage the risks and opportunities associated with social and environmental issues. RPI encompasses all kinds of efforts to address ecological integrity, community development, and human fulfillment in the course of profitable real estate investing. It seeks to reduce risk and pursue opportunities while addressing challenging public issues facing present and future generations. Its goal is to address social and environmental problems related to the built environment through better understanding of financially prudent property investments that are consistent with principles of corporate social responsibility, smart growth, green building and sustainable urbanization.

In a recent effort to rank RPI criteria based on both financial materiality and the public interest, Pivo (2008a) found agreement among real estate, investment and academic experts that a high priority should be the development of "higher density, mixed-use walkable places." However, in another study, real estate executives expressed the opinion that insufficient financial performance could be the biggest obstacle to RPI, even though 85% agreed they would increase their allocation to it if it met their risk/return criteria (Pivo 2008b). This study was designed to address this concern by examining the effects of walkability on the financial performance of real estate investments. In particular, we sought to determine whether walkable properties had market values, incomes, and investment returns that were equal to or better than less walkable forms of development. We uncovered evidence of significant effects in a nationwide set of nearly 11,000 office, retail, apartment and industrial properties using 10 years of financial data from the National Council of Real Estate Investment Fiduciaries and a new walkability measurement known as Walk Score.

This study is significant because it is the first to examine the effects of walkability per se on property income, values and returns on a national scale for office, retail, apartment and industrial properties. Walkability has become a prominent issue for real estate investors and developers as urban planners, governments, and public health leaders have increasingly embraced the goal of increasing pedestrian mobility. For example, according to a new global policy report by the World Cancer Research Fund/American Institute for Cancer Research (2009), in order to reduce preventable cancers linked to obesity and inactivity, governments should require increased walking facilities, developers should construct more projects that promote walking, and employers should occupy buildings that facilitate physical activity. This idea also was endorsed by former HHS Secretary Donna Shalala in her keynote address to the annual fall meeting of the Urban Land Institute in 2006 (Riggs 2006). Similar recommendations are emerging from global policy discussions on global warming (Ribeiro et al. 2007, Ewing and Rong 2008, Marshall 2008). Our study is also significant because it is the first to examine Walk Score, a new measure of walkability and the first to be widely used in the marketplace. Every day, over 2 million walk scores are displayed online to people interested in knowing the walkability of a property. Walk Score has been featured in over 500 print publications and 50 TV and radio segments, named as one of the 7 ideas changing real estate by Inman News, and featured in discussions by the Wall Street Journal on the growing importance of walkability in the real estate market (Front Seat 2009). Finally, this study links the subject of walkability back to the traditional literature on the determinants of property value and demonstrates how it builds on more than 40 years of related studies and reinforces our traditional framework for understanding such problems. It also makes contributions to small but significant lines of work on "local accessibility", which has been largely overlooked in the accessibility literature, and the economic consequences of land use mixing, something that was studied in the 1970s and 80s and has recently begun to reappear in the field of real estate and urban economics.

THE NATURE OF WALKABLE PLACES

Walkable places are streets and districts with physical attributes that encourage walking for functional and recreational purposes. They are found in various settings including new neo-traditional subdivisions, turn of the century streetcar suburbs (Southworth 1997), urban and suburban centers (Lang et al. 2008), greenbelt new towns (Ahrentzen 2008) and rural villages (Dalbey 2008).

Researchers have suggested that walkable places may produce a variety of environmental and social benefits. Possible environmental benefits include less air pollution, auto use, and gasoline consumption (Frank et al. 2000, Ewing and Cervero 2001, Frank and Engelke 2005). Potential social benefits include more physical activity (Frank et al. 2006, Doyle et al. 2006, Kerr et al. 2006, Pikora et al. 2006, Forsythe et al. 2007, Frank et al. 2007) and increased social capital including greater community cohesion, political participation, trust, and social activity (Leyden 2003, duToit et al. 2007). These benefits remain a topic of ongoing research, though evidence supporting them is emerging from well controlled studies (Handy 2005, Cao et al. 2006, Frank et al. 2007).

We define walkability as the degree to which an area within walking distance of a property encourages walking trips from the property to other destinations. It interacts with the property users' walking preferences and capabilities to produce the timing, quantity and distance of walking trips that occur. Several different physical and social attributes of the area around a property can affect walkability. As such, it is a multi-dimensional construct composed of different factors which together comprise a single theoretical concept. Contributing attributes include urban density, land use mixing, street connectivity (i.e. the directness of links and the density of connections), traffic volume, distance to destinations, sidewalk width and continuity, city block size, topographic slope, perceived safety, and aesthetics (Frank and Pivo 1994, Hoehner et al. 2005, Cao et al. 2006, Lee and Moudon 2006, Parks and Schofer 2006).

Of all these attributes, the presence of desired destinations within walking distance of a property may be most important. Hoehner et al. (2005) found it was the strongest correlate with home-based walking trips when compared to other social, transportation and aesthetic features. Lee and Moudon (2006) also found that distance to routine destinations, such as grocery stores, eating places and banks, is particularly useful for predicting pedestrian activity. This dimension of walkability is similar to what Handy (1992) calls "local accessibility" which is "primarily determined by nearby activity, most of which is oriented to convenience goods, such as supermarkets and drug stores, and located in small centers". As Li and Brown (1980) observed, access has traditionally been measured in relation to regional centers, but also important are access to the corner grocery, the neighborhood park, or local schools. The main difference, however, between local accessibility and walkability to desired destinations is that local accessibility presumably includes opportunities that are easily reached by all transport modes, including cars, while walkability depends on opportunities that are easily reached on foot. As such, walkability is concerned with the availability of destinations in a much smaller area around a given property than local accessibility (e.g., within ¼ to 1 square mile).

DEMAND FOR WALKABLE PLACES

Some researchers forecast growing demand for walkable places. Myers and Gearin (2001) point to a desire for walkable communities, especially among older consumers. They predict that as older consumers grow as a proportion of the total population, demand for walkability will grow as well. They also list other trends supporting this shift including growing traffic congestion, falling urban crime rates, more attractive ethnic enclaves and urban vitality produced by immigration, a growing café culture, and a growing record of fashionable and successful higher density housing. Bailey and Humphrey (2001) list additional drivers that could support the market for walkable urban places

including urban job growth, tight urban housing markets, preferences for urban amenities, and support for public policies and investments that favor revitalization, alternative transportation modes, historic preservation, and urban parks and open space. Shiller (2007) has recently suggested that concerns about pollution, the environment and energy conservation may stimulate a move toward walkable urban centers, though he is uncertain it will occur, and if it does, he thinks it could take many years. But others conclude that unmet demand already exists today. Levine and Inam (2004) found in a national survey that developers perceive considerable interest among consumers in alternatives to "conventional, low-density, automobile-oriented suburban development" including higher density, mixed use, pedestrian oriented places. They also found that developers think there is an inadequate supply, which they attribute to restrictive local government regulations. A survey of residents in Boston and Atlanta by Levine et al. (2002) supports the developers' impressions: there seems to be a mismatch between the desire for pedestrian-friendly neighborhoods and the choices available to consumers. A more recent study by Levine and Frank (2006) also found a correlation between the desire for walkability and the desire for neighborhood change, lending further credence to the view that there is an undersupply of walkable neighborhoods relative to demand. Generally then, there may be an unmet demand for walkability that is increasing with the passage of time.

THE EFFECTS OF WALKABILITY ON PROPERTY VALUES AND RETURNS

Developers and investors would be key players in the creation of more walkable cities, but the real estate economics of walkability is not well understood. Does it add or detract from property values? How does it affect investment risks and returns? If walkability improves profits and returns, we could expect the private sector to produce more walkable places, so long as land use controls permit it (Levine 2006). If, however, the financial effects are more neutral or negative, then producing more walkable places may require public subsidies, mandates or partnerships.

WALKABILITY AS A DETERMINANT OF URBAN LAND VALUES

Determinants of urban land values have been studied for over 100 years. Seminal works focused on the role of accessibility and transportation systems (Hurd 1903, Haig 1926, Alonso 1960), but scholars have long understood that other factors, such as site advantages, can also be consequential (Wendt 1957). Brigham (1965) was perhaps the first to offer a comprehensive set of determinants and to quantify their contribution using regression analysis. In his work on single-family home values, he identified four groups of explanatory factors: accessibility (e.g. distance to workplaces and other desired destinations), amenities (e.g., air quality), topography (e.g., slope, elevation and views) and historical factors (i.e. conditions extant when development occurs). Within 10 years, Stull (1975) was able to observe that "it has become customary to think of a single-family parcel as a bundle of characteristics" that can be classified into four "mutually exclusive and exhaustive" categories including accessibility (e.g., distance to desired destinations), physical site characteristics (e.g., building age), environmental features around the parcel (both social and bio-physical), and public sector factors (taxes and services).[3]

Walkability seems to fit rather well within this traditional theory of land value determinants with one exception; the factors that determine walkability bridge two of Stull's categories. The presence of

[3] Ball (1973) reviewed the work of these and other pioneers. Since then, the research has been extended to cover nonresidential properties and other determinants beyond Stull's four categories including buyer and renter characteristics, property management quality, lease provisions, regional economic drivers and macroeconomic conditions (Ogur 1973, Hoag 1980, Guntermann and Norbin 1987, Glascock et al. 1990, Sirmans and Benjamin 1991, Mills 1992, Ambrose 1990, Sirmans and Guidry 1993, Asabare and Huffman 1996, Kim and Nelson 1996, Benjamin et al. 1997, Buttimer et al. 1997, Sivitanides 1998, Frew and Judd 2003, and Rosiers et al. 2005.

desired destinations within walking distance falls within the "accessibility" category, while factors such as path connectivity, topography and safety would fit under "other environmental features around the parcel". Walkability includes characteristics that may not fit neatly into just one of the traditional "mutually exclusive" categories, but neither does it require going beyond the categories identified by Stull over 30 years ago.

Most of the work by Brigham, Stull and others focuses on single family property values. In this paper, however, we look at offices, apartments, retail and industrial properties. Is the prior work transferable? Following traditional reasoning about accessibility, one could argue that walkability can be expected to lower the cost of transportation to food, recreational, financial, and retail services which are desired by the tenants, workers, and customers who frequent these other types of buildings. And in a world of more single adult and two-worker households, where time budgets for daily tasks are severely constrained, as well as a world of growing traffic congestion and transportation costs, where the costs of mobility are rising, it may well be easier in more walkable places for apartment owners to attract and retain renters, for office, retail and industrial employers to attract and retain employees, and for retailers to attract customers. These benefits to tenants would then be capitalized into higher rents and lower turnover, which would increase property incomes and values.

It is possible that walkable places have other merits as well that are capitalized into property values. For example, they may be more widely recognized as distinctive "places" with greater prestige than other locations, which, as Gertrude Stein famously put it, "have no there there". Walkable places may also be valued for the interesting diversity, sense of community and vitality which they can offer the residents, workers, and customers who use them.

Thus, in theory, there are reasons to expect higher property values in more walkable places. Although we have no empirical papers so far directly confirming it, there are a number of related studies that would support the proposition that walkability increases property values.

Two teams of researchers have examined the value of "new urbanism" or "traditional neighborhood development", which emphasizes pedestrian-oriented design. Tu and Eppli (1999) studied Kentlands, a community in Gaithersburg, Maryland which they describe as "one of the best and most complete" new urbanist cases. Using data on single family home transactions and hedonic models, they found a 12% premium for Kentland properties. They later expanded their work to include cases from Sacramento and Chapel Hill and again found a 4 to 15% premium which could not be explained by housing characteristics other than the more pedestrian-friendly design (Tu and Eppli 2001). Similar work was completed by Song and Knaap (2003) on the Portland, Oregon region. They looked at separate measures of urban form that are associated with walkability, including the percent of homes within ¼ mile of commercial uses and bus stops, density, mixed use, circulation system design, and the availability of non-auto travel modes. They found buyers prefer pedestrian access to commercial uses and a 15.5% premium for houses in neighborhoods with new urbanist features.

Other researchers, studying the determinants of rent, have included variables in their analyses that pertain to walkability. Sivitanidou (1995) looked at the effect of "utility-bearing worker amenities" on office rents in over 1,400 properties in the Los Angeles area and found that the level of retail amenities in the surrounding area increased rents. This is consistent with Mills (1992) who found that the presence of a bank and restaurants in an office building increased office rents per square foot. Working on apartment buildings, Des Rosiers and Theriault (1996) found that the distance to primary schools and shopping centers were inversely related to rents. Except for Mills' work, its unknown whether the schools and shopping examined by these researchers were within walking distance of the properties, but their positive association with rent suggests that access to them is an amenity for office workers and apartment tenants that can increase rents and values.

Other work has focused on the effect of land use mixing on residential property values. This line of work grew from interest in the effectiveness of zoning; particularly whether separating land uses improves property values. These studies were not concerned with walkability *per se*, but land use mixing, which is analogous to proximity to desired destinations.

According to Matthews (2006) there are two views, grounded in urban economic theory, on how the presence of nonresidential uses in a residential area should affect home values. On the one hand, microeconomic theory predicts that value is related to transportation costs. So as the distance to destinations, like work or shopping or entertainment, declines with less separation between uses and increased mixing, residential values should increase. This has been called the proximity effect. It should be noted, however, that this increase in value should come about because it is less expensive to access opportunities by all modes of travel, not just by walking. So, even if land use mixing and greater proximity to desired destinations improves walkability, it is not just the greater ease of walking that would drive values higher, it is the lower cost of all forms of transportation that is being capitalized into property prices. This should be kept in mind later when considering the results of our study. Nonetheless, walkability can be associated with higher property values, even if those higher values are not the result of greater walkability alone.

The second view on how nonresidential uses should affect home values recognizes that there may be disamenity effects from land use mixing. Nonresidential uses can produce negative externalities, such as noise, traffic or litter, and that can reduce residential values.

Some prior empirical work found no evidence that land use mixing affects property values (Crecine et al. 1967, Rueter 1973). Other quantitative studies produced evidence that both proximity and disamenity effects are operating simultaneously. For example, Kain and Quigley (1970) found evidence of the disamenity effect when they showed that commercial and industrial uses in the immediate vicinity of housing lowered apartment rents and single-family home values. Stull (1975) also found that industrial, vacant and multifamily land uses negatively affected single family values as did commercial properties after it exceeded 5% of the land area. More recently, Mahan, Polasky and Adams (2000), found a negative relation between residential values and proximity to commercial and industrial zones. All of these studies demonstrate disamenity effects on residential uses from land use mixing. However, evidence of proximity effects on residential values, especially from commercial and recreational uses, has been published by Li and Brown (1980), Cao and Cory (1982), and Song and Knaap (2004).

Li and Brown (1980) and Colwell et al. (1985) have paid particular attention to the trade-off between the proximity and disamenity effects. They hypothesize that the net of the two effects on home values is negative where non-residential uses are close to homes and positive farther away.

After reviewing much of this literature, Matthews (2006) concludes that both positive and negative effects may decline with distance, and that the negative effects probably extinguish more quickly than the positive ones producing a net benefit reflected in higher values for residential uses located more than a minimum and less than a maximum distance from nonresidential uses. He goes on to combine this conclusion with data that suggest that the effect of proximity depends on street layout. For example, curvilinear and cul-de-sac streets can make it difficult to access retail services from homes even if they are close by as measured by straight-line distance. The net benefits are only possible when desirable destinations are both proximate and accessible (Matthews 2006, Matthews and Turnbull 2007). This important insight, that accessibility is a function of both proximity and connectivity, was also offered by Brigham (1965) four decades earlier.

There are two additional conclusions suggested by the literature. One is that once the mix of nonresidential uses exceeds a certain level in an area, the disamenities effects may begin to dominate. The other is that some non-residential uses, such as retail, parks, and offices, tend to have a more

favorable impact on single family values compared to apartments and industrial uses. It seems logical to expect that both the precise amount and the specific mix of uses in an area can affect property values. Moreover, each type of property may differ in how it responds to different amounts and types of other uses. For example, shops and parks and restaurants may benefit residents in homes and apartments and workers in non-residential properties, while industrial uses may always do best when located away from homes and shopping. A search for such "optimum blends" has not been conducted by researchers so far, but it is logical to expect specific uses to benefit most from proximity to a specific amount and mix of other uses.

Market Values and Investment Returns

All of these prior studies suggest that walkability could well produce higher property values. If demand for walkable places is growing and currently exceeds supply, if homes in new neighborhoods designed to promote walking sell at a premium, if access to schools, banks and shopping increase office and apartment rents, and if land use mixing increases property values, then it seems reasonable to hypothesize that walkability improves rents and values. But properties which produce more income at any given point in time will not automatically generate higher investment returns if the higher income was already expected when the property was acquired and purchased at a price that reflects that expectation. Assuming the same risk, for actual (*ex post*) returns to be higher for walkable properties, income would have to be higher than was expected when the property was acquired or appraised. This is because property values are generally a function of expected earnings, given a certain level of risk. If income for walkable properties was higher than expected, they would have generated higher *income returns*. And if walkable properties appreciated more than was expected, due to faster than expected income growth or a decline in perceived relative risk, they would have generated higher *appreciation returns*.

Prior studies have shown that certain macroeconomic conditions affect property returns including GDP, inflation, vacancy rates, and employment growth (Sivitanides 1998, de Wit and Van Kijk 2003). But unanticipated effects in these conditions would likely have the same effect on both more and less walkable properties. Unanticipated effects on incomes or values that might selectively affect more walkable properties could include changes in the cost of vehicular transportation and congestion, a cultural shift in favor of health and exercise, or more favorable attitudes toward street life and urbanism. The demand studies, discussed above, point to recent trends which may not have been anticipated by investors and could have uniquely affected more walkable properties. If, as some argue, demographic changes and other factors are causing an unanticipated shift in demand toward more walkable properties, then unexpected growth in earnings and values could well have caused more walkable properties to outperform as investments.

So, the effects of walkability on property values and incomes on the one hand and investment returns on the other must be considered as two separate questions. Values will be higher if there are benefits from walkability that are capitalized into property prices. Returns will be higher if incomes or appreciation are larger than were expected when walkable properties were appraised or acquired.

Based on this review, we concluded that walkability may well be producing benefits that are reflected in higher market values and incomes. We also suspected that a shift may be occurring in the marketplace in favor of more walkable places which has not been fully anticipated by investors or appraisers. Therefore, we hypothesized that walkable properties have been valued as much or more and produced investment returns as good as or better than other more auto-oriented real estate.

METHODS

To test our hypotheses we combined real estate performance information from the National Council of Real Estate Investment Fiduciaries (NCREIF) with walkability data from Front Seat. NCREIF is a non-partisan source of real estate performance information based on property-level data submitted by its data contributing members, which include tax-exempt institutional investors and investment managers. Front Seat is a civic software company that developed Walk Score, an online tool that provides walkability ratings for any address in the USA.

NCREIF has information on the financial performance, physical features and location of over 23,000 office, apartment, retail, industrial and other properties. Properties owned by contributing members are included in the pool, and added or removed as the members acquire or sell holdings. The financial data for each property are quarterly observations for those quarters when it was held by a contributing member. Most properties do not have quarterly financial information from 1977 until the present because they were not held for this entire period.

For our work, we selected all stabilized office, apartment, retail and industrial properties that were in the NCREIF pool for at least one quarter from 1998-2008. We then found the latitude and longitude for each of these properties that had a complete address in the data set. That came to a total of 10,981 properties. We then obtained Walk Score ratings from Front Seat for each of these locations.

Because the dataset increases in the quarter a new property is acquired (or a new member joins NCREIF and starts contributing) and data is no longer available in quarters after a member sells a property to a non-member, the sample size varied from 2,365 to 5,543 properties in our dataset for any given quarter. Altogether, we had 26,775 quarterly observations with all variables for the 10,981 buildings with Walk Score ratings.

We used ordinary least squares regression analysis to examine the impact of Walk Score on the financial performance of properties while controlling for other factors that might impact financial outcomes. Financial performance measures included end of quarter market values, yearly capital returns, yearly income returns and yearly total returns. Table 2 gives definitions and summary statistics for the variables used in the study.

Table 2: Variable definitions and summary statistics

Variable	*Definition*	*Obs.*	*Mean*	*Std. Dev.*	*Min.*	*Max.*
Walk Score	Walkability index based on distance to desired destinations	92776	60.93976	22.59492	0	100
mv	Market value of the property at the end of the quarter	27130	205.0022	191.4313	.7140487	8432.54
noi	Net operating income per square foot	159805	2.300528	2.063036	.0000205	48.3315
logincret_yr	Log of the income return (cap rate) for the current and prior three quarters	133539	.0725236	.0325368	-1.060056	1.592711
logappret_yr	Log of capital return for the current and prior three quarters	133533	.0279389	.137858	-5.868715	4.266578
logtret_yr	Log of 1 + total return for the current and prior three quarters	133537	1.115917	.2192044	-13.12456	32.00616
cemp123	Employment growth in CBSA for past three quarters (percent)	149335	1.669767	2.012065	-8.734068	25.63652
sta123	Annual average construction completions specific to each property type property type in a CBSA as a percent of existing stock for past three years	174054	1.812055	1.688501	0	29.01772
npitotret	Quarterly return for all properties in the NCREIF Property Index	168936	.025612	.0238048	-.0828616	.0548936
age	Age of the property (years)	157396	16.91554	13.35585	-4	128

sqft	Size of the property (square feet)	168936	307012.5	580897.3	1	1.18e+08
proptaxmsa	Effective tax rate per $ of property value	95941	1.466039	.7871817	.068545	33.62266
propcrime	Property crimes in city per 100,000 capita	136674	5860.397	20020.52	0	513978.5
PersonsSqMi	Persons per square mile of land area in the city or census designated place	10913	4371	4214.563	16	52978
transithalf	A dummy variable where 1 = within ½ mile of a fixed rail transit station	10941	.128	.334	0	1
ttime	Mean travel time (minutes) from home to work in the census tract for all workers and all 11 categories of means of transportation to work	10919	24.581	5.698	0	71
stype	A dummy variable where 1 = in CBD	27130	.1689642	.3747272	0	1
CBSA	Dummy variables where 1 = in a specific Core Based Statistical Area					
lptype	Dummy variables where 1 = a specific property type					

WALK SCORE

The walkability measure used in our work was Walk Score. It calculates the walkability of an address by determining the distance to educational (schools), retail (groceries, books, clothes, hardware, drugs, music), food (coffee shops, restaurants, bars), recreational (parks, libraries, fitness centers), and entertainment (movie theaters) destinations. The algorithm awards points based on distance to the closest destinations using Google Maps. If the closest establishment in a category is within one-quarter mile, Walk Score assigns the maximum number of points for that category. The number of points declines as the distance approaches 1 mile and no points are awarded for destinations further than 1 mile. Each category is weighted equally and the points assigned to each category are summed and normalized to yield a score from 0–100.

Some of the destinations analyzed in Walk Score are most likely to be accessed from homes or hotels (e.g., movie theaters and schools) but most could be desired destinations from both residences and workplaces. Consequently, it is reasonable to expect Walk Score to have an economic effect on both residential and nonresidential properties. Positive effects would likely be greatest for buildings whose value is most sensitive to the locational advantages, amenities and services it provides its occupants. So walkability may be more beneficial to apartments and office buildings than to industrial and retail properties. For industrial properties, there might actually be a negative effect because of the desire to avoid conflicting land uses and pedestrian activity. For retail properties, the effect that should be expected is less clear. Higher Walk Score could mean more competition but it could also mean more foot traffic and agglomeration economies.

A few limitations of Walk Score should be noted. First, it weights all destinations equally. However Lee and Moudon (2006) found that out of 24 destinations considered, only groceries, schools, banks, restaurants and bars were significantly associated with home-based walking. Walk Score does not count banks. It also is possible for a property to have a relatively high Walk Score without being close to these more significant destinations. A second limitation of Walk Score is that it does not account for other factors that have been empirically or theoretically linked to walkability. The most notable of these is connectivity. As noted above, walkability is a function of both proximity and connectivity. Walk Score measures proximity but it does not consider topography, physical barriers, connectivity and street patterns which can affect accessibility (as measured by travel time, effort, or distance) to proximate destinations (as measured by straight line distance). Other correlates of walking not measured by Walk Score include block size, sidewalk length and width, population density and security (Hoehner et al. 2005, Lee and Moudon, 2006).

Despite these limitations, Walk Score offers two important advantages. First, it measures proximity to desired destinations, which prior research has found is the best predictor of walking. Second, it covers all properties nationwide, allowing it to be used for a national study in combination with the NCREIF data set. Both Moudon and Lee (2003) and Parks and Schofar (2006) discuss other more comprehensive indices of walkability, but so far no one approach has become the standard and no other measure of walkability is available nationally other than Walk Score.

Two additional caveats should be mentioned. First, Walk Score is not a traditional measure of land use mixing which is usually measured by taking into account the total amount and intensity of other land uses in a given area. Walk Score only measures whether there is at least a single case of various establishments nearby. It does not recognize the size or intensity of those uses, it does not count the percentage of a given area devoted to various uses, and it does not measure uses other than the 13 that it tracks. The reader should therefore be careful when comparing the findings from this study to other work dealing with land use mixing. While Walk Score does capture a particular type of land use mixing, it is a unique measure of that phenomenon (Hess et al. 2001, Krizek 2003). Second, Walk Score captures accessibility to desired locations within walking distance from a given origin. But, as we previously noted, any economic value associated with higher walk scores probably reflects the value of greater accessibility by other travel modes as well. As we previously warned, the reader should be careful not to assume that any added value from higher walk scores is only due to the added value placed by consumers on the ability to walk. In all likelihood it also reflects the value placed on the ability to quickly drive or bicycle to nearby destinations. Nonetheless, the fact that walkability may produce accessibility benefits for non-walkers does not diminish the validity of findings that walkable urban form is associated with higher property values. It only means that it brings with it an indivisible package of benefits that accrue to other forms of transportation as well.

Figure 1 gives two examples of the Walk Score method using maps of two neighborhoods in Jacksonville, Florida. On each map there is a star showing the location of a property being scored and icons indicating the locations of destinations surrounding the property. Tables are also presenting listing distances to the nearest destinations of each kind. The map for the San Marco neighborhood also illustrates one of the limitations of the method. There is an east-west freeway that may block access from the property being scored to services north of the freeway. The Walk Score protocol, however, does not account for such barriers which, if impenetrable, should lower walkability. To help the reader interpret our findings presented later in the paper, we will compare our results in terms of properties with walk scores of 80 and 20. Figure 1 should help the reader understand the difference between such scores.

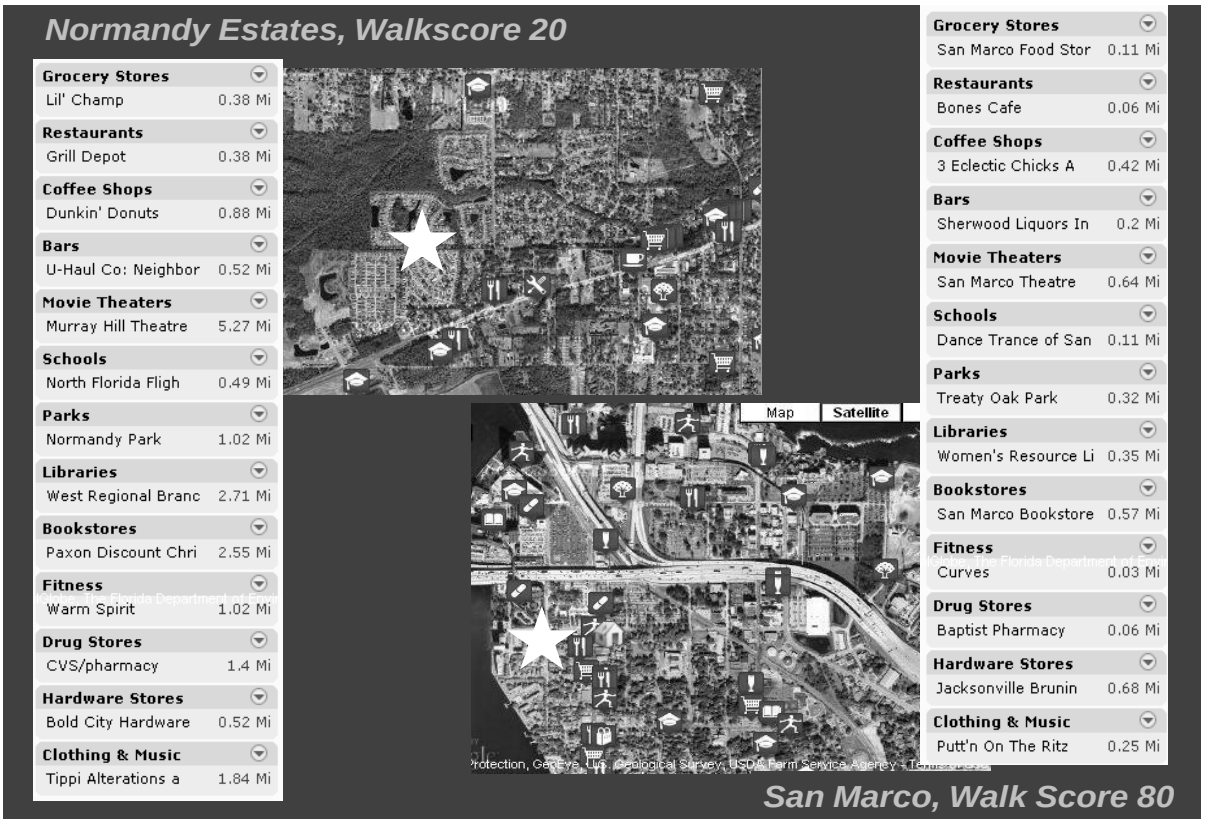

Figure 1: A comparison of two neighborhoods in Jacksonville, Florida with low and high walk scores.

Financial Variables

Actual accounting data for whole buildings were provided by NCREIF on quarterly investment returns and market value. Market values are based on standard commercial real estate appraisal methodology. The log of the end of quarter market value was used in the market value regressions. Return variables were based on the compound return over the current and prior 3 quarters. The log of 1 + return was used in the return regressions. Three components of return were analyzed: Income Return which measures that portion of total return attributable to each property's net operating income, Capital Return which measures the change in market value from one period to the next and Total Return which is computed by adding the Income Return and the Capital Return.

Control Variables

Prior studies on urban land values and investment returns have identified a variety of explanatory factors. In order to isolate the effects of walkability, we introduced controls for many of these factors. The NCREIF market index was used to control for macroeconomic changes in the market over time. Appraisal smoothing was not an issue for this study because the index and the returns for individual properties were both appraisal based (Fisher and Geltner 2000). Regional employment growth was used as a measure of local demand. Regional construction starts (for each property type studied) was used as a measure of local supply. Dummy variables were used to control for regional location, as well as whether office properties were in a CBD or suburb[4]. We used Core Based Statistical Area (CBSA) dummy

[4] CBD or suburb location is considered an office property sub-type by NCREIF and was available for office properties only.

variables instead of regional dummy variables but the results were the same regardless of which variables were used. Any factor not otherwise controlled and which varied systematically by region was controlled for by the CBSA dummies. This includes climate, which could affect the degree to which walkability is valued by building users. Building size and age data available from NCREIF were used to control for individual property characteristics. Property crime rates at the city-level published by the U.S. Department of Justice for 2006 were used to control for security conditions. Effective tax rate paid by each property was computed from NCREIF tax expenditure and property value data and was used to control for the cost of local government services.

We also controlled for regional accessibility from each property's location. Locations may be more walkable because of the higher local accessibility that comes from the higher density normally associated with increased regional accessibility. It was therefore important to control for regional accessibility. We did this by using three proxies for regional accessibility: a dummy for whether or not the property was within ½ mile of a fixed rail transit station, the mean travel time to work by all modes of travel from homes in the census tract of each study property, and the population density in the city in which each study property was located. Transit station locations were obtained from the US Bureau of Transportation Statistics and Google Earth, journey to work times were obtained from the 2000 US Census Transportation Planning Package, and density was obtained from the US Census. We would have used traditional gravity-based and distance to CBD measures but it was infeasible to obtain them for our large number of study properties (Song 1996, Geurs and Wee 2004). Nevertheless, Levinson (1998) has demonstrated that journey to work time by car or bus is a good proxy for gravity-based accessibility measures and according to Heikkila and Peiser (1992), accessibility depends on urban density.

Regression Models

Models were developed that evaluated the effect of walkability on value and returns. Some were computed using all the properties regardless of type. In that case property type dummies were included. [5] Otherwise, variables in the models were the same. The only exception to this was for the office property models, which included an additional dummy variable for subtype (CBD/suburban location).

All models were of the following form:

> Financial performance = f (walkability, regional supply, regional demand, national property market performance, individual building characteristics, regional market location, local security conditions, property tax rates, density, transit access, journey to work time)

Data were cross-sectional and time-series. The number of observations in any particular regression depended on the specific variables used because of missing variables (null values) for some data points for some properties.

Table 3 gives the correlations among the control and Walk Score variables. None of the variables were highly correlated indicating an absence of multicollinearity problems.

[5] One is dropped to avoid the perfect multicollinearity problem.

Table 3: Correlations

	Walk Score	*cemp123*	*sta123*	*npitotret*	*Age*	*sqft*	*proptaxmsa*	*propcrime*	*persons SqMi*	*transithalf*	*Ttime*
Walk Score	1.00										
Cemp123	-.11	1.00									
sta123	-.07	.17	1.00								
npitotret	-.01	.01	-.24	1.00							
Age	.26	-.12	-.10	.06	1.00						
sqft	.08	-.02	.00	-.03	.09	1.00					
proptaxmsa	-.03	-.06	.11	-.17	-.04	.03	1.00				
propcrime	-.00	.03	.05	.00	.05	.03	.04	1.00			
personsSqMi	.45	-.19	-.10	.02	.35	.12	-.02	-.08	1.00		
transithalf	.50	-.17	-.08	.02	.26	.12	.01	.05	.55	1.00	
Ttime	-.21	.03	-.05	.03	-.08	-.02	-.13	-.13	-.03	-.12	1.00

ANALYSIS AND RESULTS

MARKET VALUE

Table 4 presents our results for market value per square foot. Nearly all controls were significant and had the expected signs. The few exceptions are discussed below. The goodness of fit for each model, as indicated by the R-squares, varied from .61 to .79. Our focus, however, was on the coefficient and significance of Walk Score, not the total explanatory power of the models.

In every model, Walk Score was positively associated with market value per square foot. Converting the coefficients to percent change equivalents, a 1 unit increase in Walk Score produced a 0.67, 0.82, 0.48 and 0.63 percent increase in market value for office, retail, apartment and industrial properties, respectively.[6] All else being equal, an office property with a Walk Score of 80 would have been worth about 40.3% more per square foot than a property with a Walk Score of 20. For retail, apartment, and industrial properties the walkability premium was 49.2%, 28.6% and 38.1%, respectively.

We were surprised to find such a high premium for industrial properties. Even though most of the industrial properties in the data set were warehouses, we thought that non-industrial uses and pedestrians might conflict with the trucks, trains and noise found in industrial warehouse districts. We did not control for certain building variables which others have found to add value to industrial properties, such as ceiling height, office space, dock-high doors, drive-in doors, and airport proximity (Ambrose 1990, Fehribach et al 1993, McDonald and Yurova 2007), but we do not think these features covary with walkability, so we do not think that controlling them would have significantly changed the results.

It was also interesting to find that walkability had the least positive effect on apartment properties. Prior studies, however, have found both positive proximity and negative disamenity effects on residential property values from nearby non-residential uses, with the disamenity effects of non-residential uses increasing as they get closer to homes. Our findings could indicate the presence of such mixed effects, especially because the Walk Score protocol assigns the highest score to apartments with the most types of non-residential uses within ¼ mile. In these circumstances there could be insufficient distance between the apartments and nonresidential uses to fully extinguish any negative externalities. We suspect the reason we did not see this effect as strongly for other uses was that the disamenities from nonresidential uses (i.e. noise, traffic, litter) may have more disutility for apartment dwellers than for the workers, customers, clients, and tenants that use other types of properties.

[6] The squared and cubed values of Walk Score also were significant when entered in the model indicating some non-linearity in the relationship between Walk Score and market value.

There were also two unexpected results in the controls worth noting. First, property size had a significantly positive effect in the retail model while a negative one in the others. This presumably indicates agglomeration economies in the retail sector. Second, density had an insignificant effect on retail while it was positive in the other models. It could be that for retail, negative congestion affects from density were offsetting its positive accessibility effects. According to Heikkila and Peiser (1992), rents are positively influenced by two factors: accessibility and spaciousness and both depend in opposing fashion upon urban density. As density increases, accessibility is increased but spaciousness is reduced. This is why Levinson (1998) refers to both the economies and diseconomies of density.

Table 4: Regression results for log of market value per square foot

	All Types	*Office*	*Retail*	*Apartments*	*Industrial*
Walk Score	.0063164***	.0066945***	.0081691***	.0047504***	.0063331***
cemp123	.0540864 ***	.0640205***	.0267835***	.0395516***	.05586***
sta123	-.0113269***	-.009442**	-.0370382***	-.0748716***	.0105349
Npitotret	9.77037	8.211007***	13.71128***	7.906777***	6.868638***
Age	-.0041682***	-.0057078***	-.0002373	-.0047535***	-.0039648***
Sqft	-5.13e-08***	-7.61e-08***	1.24e-07***	-1.95e-07***	-1.74e-07***
Proptaxmsa	-.0806092***	-.0709919***	-.1029436***	-.032852***	-.0295357***
Propcrime	-5.73e-06***	-.0000216***	-.0000382***	-.0000249***	-.0000469***
personsSqMi	5.25e-06***	.0000197***	-6.66e-06	.0000153***	9.16e-06***
Transithalf	.0830845***	.0514321***	.3187512***	.2865266***	. 0560999**
Ttime	-.0150792***	-.0164785***	-.0171303***	-.006359***	-.012164***
Stype		-.0023667			
lptype_2	.345259***				
lptype_3	-.6094489***				
lptype_4	(dropped)				
lptype_5	.2006015***				
lptype_6	.5479329***				
lptype_7	-.6714876**				
CBSA dummies	not shown	not shown	not shown	not shown	not shown
Number of obs	26778	8584	2870	6174	8413
R-squared	0.7289	0.6667	0.6268	0.7855	0.6080
Prob > F	0.0000	0.0000	0.0000	0.0000	0.0000

* = sig. at .05 level, ** = sig. at .01 level, *** = sig. at .001 level

NET OPERATING INCOME

Table 5 presents our results for net operating income (NOI) per square foot. Since property values are normally a function of the income they produce, we expected walkability to be associated with higher incomes and that is exactly what we found. For each 1 unit increase in Walk Score, we found that NOI per foot was 1.9 cents higher for office, 2.5 cents higher for retail, 2.1 cents higher for apartments, and 1.1 cent higher for industrial. Comparing properties with 80 and 20 walk scores, NOI per foot would be $1.14 (34.0%) higher for office, $1.50 (45.0%) higher for retail, $1.26 (71.2%) higher for apartments, and 60 cents (54.1%) higher for industrial. For apartment and industrial properties, the percentage increase in NOI was at least as large as the percentage gain in market value. This meant that the higher market values from walkability could be fully explained by the higher incomes they produced. For office and retail, however, higher incomes were insufficient to fully explain the higher values. However, as we will see in the next section, an additional portion of higher market values could be explained by lower cap rates, which tend to increase value independent of NOI.

Table 5: Regression results for net operating income per square foot

	All Types	*Office*	*Retail*	*Apartments*	*Industrial*
Walk Score	.0039122*	.0188701***	.0253973***	.021041***	.0112578***
cemp123	.1832811 ***	.1702805***	.0455303	.1206732***	.0270737***
sta123	.0070402	.121263***	-.1439591**	.1034662	.1126293***
Npitotret	8.172533***	3.882468	23.07306***	6.205342	.6046186
Age	-.0240594***	-.0190724***	-.0098849***	-.0213478***	-.0089737***
Sqft	-2.62e-07***	-3.66e-07***	3.15e-07***	-1.09e-06***	-2.88e-07***
Proptaxmsa	-.2827746***	-.3528935***	-.3249661***	-.0798228	.0004885
Propcrime	-.00004***	-.0000715 ***	-.0002146***	-.0002475***	-.0000743***
personsSqMi	-.0000652***	.0000523***	.000081*	.0000633***	.0000509***
Transithalf	.3414117***	-.0240178	1.677969***	2.244931***	.2144181***
Ttime	-.0439833***	-.0632021***	-.1191083***	.0684238***	-.0229345***
Stype		-.309191***			
lptype_2	3.103497***				
lptype_3	-.7575911***				
lptype_4	(dropped)				
lptype_5	1.250265***				
lptype_6	2.564329***				
lptype_7	-4.688073***				
CBSA dummies	Not shown	Not shown	Not shown	Not shown	Not shown
Number of obs	26778	8584	2870	6174	8413
R-squared	.2425	.3614	.5215	.4392	.2750
Prob > F	.0000	.0000	.0000	.0000	.0000

* = sig. at .05 level, ** = sig. at .01 level, *** = sig. at .001 level

RETURN ON INVESTMENT

We now turn to our analysis of annual investment returns over the 10 year study period. Table 6 gives the results for appreciation, income and total returns for models that include all properties in the study regardless of property type. The control variables in these models were the same ones used in the market value model for all properties. Similar models were produced separately for each type of property. Table 7 gives the Walk Score coefficients from these models.

With respect to appreciation returns, more walkable offices appreciated quicker while more walkable retail appreciated slower than less walkable properties. Effects on apartment and industrial property were insignificant. Converting the coefficients to percent change equivalents, an office property with an 80 Walk Score would have appreciated 2.4% faster per year than one with a 20 Walk Score, all else being equal, while a retail property with an 80 Walk Score would have appreciated 3.0% more slowly per year. These results suggest that the market value premiums from walkability reported in the previous section were growing for offices during the study period, shrinking for retail, and holding steady for apartments and industrial. One explanation for the shrinking premium in walkable retail could be the success of auto-oriented big box and power centers during the last decade which depend on auto-oriented shopping trips by design.

With respect to income returns (cap rates), we found that higher walk scores were associated with lower annual income returns. This means that investors were paying more for each dollar of income produced by more walkable properties. Lower income returns are analogous to lower cap rates. Properties normally have lower cap rates when they are considered safer investments or expected to either appreciate faster or depreciate slower than other properties over time. Table 6 gives the income return results for each property type. Although the coefficient for Walk Score was negative for each type of property, it was only significant in the retail and apartments models. A 1 point increase in Walk Score was associated with a .015 and .005% lower income return for retail and apartments, respectively. A retail and apartment property with an 80 Walk Score would have had a .88% and .31%

lower cap rate, respectively, than a retail and apartment property with a 20 Walk Score.

Total return is the net result of income and appreciation return. It is computed by summing appreciation and income returns. For offices, the positive effect of walkability on appreciation returns and the insignificant effect on income returns netted a significantly positive effect on total returns. Each unit increase in Walk Score increased annual total returns by .04%. For retail and apartments, negative effects from walkability on both appreciation and income returns resulted in lower annual total return of .06% and .02%, respectively. The effects on industrial properties remained insignificant. In practical terms, this means that an office property with an 80 Walk Score would have earned an annual total return that was 2.3% higher, a retail and apartment property with an 80 Walk Score would have earned an annual total return that was 3.7 and 1.2% lower, and an industrial property with an 80 Walk Score would have earned a return that was no different than properties of the same type with 20 walk scores. To put these effects in context, consider that annual total returns reported by NCREIF during the 1998-2008 study period averaged 11 to 12% for offices, retail and apartments. Clearly, the effects of walkability are consequential as a proportion of average total returns.

Table 6: Regression results for return measures for all property types

	logappret_yr	*logincret_yr*	*logtotreturn_yr*
Walk Score	-.0000289	-.0000638***	.0000943
cemp123	.0153117***	-.0012073***	.0138687***
sta123	-.0024204**	.0014127***	-.0063344***
Npitotret	3.907109***	-.4935133***	3.195264***
Age	-.0001484*	-.0000217**	-.000171**
Sqft	1.03e-08***	-7.52e-10**	9.54e-09***
Proptaxmsa	-.0205211***	.0016323***	-.0185895***
Propcrime	-6.01e-07**	1.47e-07***	-4.42e-07*
personsSqMi	1.06e-06***	-3.23e-08	1.02e-06***
Transithalf	.0148626***	-0011461**	.0138687***
Ttime	-.0001799	.0001838***	.0000323
lptype_2	-.033616***	.027204***	-.0061544
lptype_3	-.0160527***	.0135332***	-.0020229
lptype_4	(dropped)	(dropped)	(dropped)
lptype_5	-.0188582***	.0128222***	-.005464*
lptype_6	.0090978***	.0143087***	.0231632***
lptype_7	(dropped)	(dropped)	(dropped)
CBSA dummies	not shown	not shown	not shown
Number of obs	22567	22557	22558
R-squared	0.2427	0.2142	0.2066
Prob > F	0.0000	0.0000	0.0000

* = sig. at .05 level, ** = sig. at .01 level, *** = sig. at .001 level

Table 7: Walk Score Effects on Returns by Property Type

	Office	*Retail*	*Apartments*	*Industrial*
Appreciation Return	.0004232**	-.000494**	-.0001517	-.0000548
Income Return	-.0000279	-.0001461***	-.0000523***	-8.75e-06
Total Return	. 0003879**	-.0006243**	-.0002022*	-.0000667

* = sig. at .05 level, ** = sig. at .01 level, *** = sig. at .001 level

SUMMARY AND CONCLUSION

We hypothesized that walkable properties have had income and values that were as much or more and produced investment returns as good as or better than less walkable investments. We tested our hypotheses using 10 years of data for over 10,000 properties of various types from throughout the US. Table 8 summarizes our results. Our hypothesis for market values and net income were confirmed, but our hypothesis for investment returns was only partially correct.

Table 8: Summary of Results for 80 vs. 20 Walk Scores

Property Type	*Market Value*	*NOI*	*Appreciation Return*	*Income Return*	*Total Return*
Office	+40%***	+34%***	+2.54%**	-0.17%	+2.33%**
Retail	+49%***	+45%***	-2.96%**	-0.9%***	-3.74%**
Apartment	+29%***	+72%***	-0.91%	-0.31%***	-1.21%*
Industrial	+38%***	54%***	-0.33%	-0.05%	-0.40%

* = sig. at .05 level, ** = sig. at .01 level, *** = sig. at .001 level

Walkability was associated with higher value for all types of properties. Properties with a Walk Score of 80 were worth 29% to 49% more than properties with a score of 20. Consistent with their higher values, we found higher net operating incomes for all property types as well.

Walkability only had a positive effect on historical investment returns for offices. More walkable offices had a significantly faster appreciation rate and an insignificantly lower income return, resulting in a total return that outperformed more auto-oriented office properties. More walkable retail, on the other had had a significantly slower appreciation rate, which combined with a lower income return resulted in underperformance in total returns in comparison to more auto-oriented retail outlets. Returns for apartments were similar to retail, though not as negative and the lower appreciation returns were not statistically significant. Only industrial property returns were unaffected by their walkability scores. Thus, it appears that investors in walkable office properties enjoyed higher returns even though they paid a premium to own them while investors in walkable retail and apartments may have paid too much, given the returns they received. It is interesting to note, however, that the higher value for apartment and retail seem justified by their higher NOI. Perhaps the problem was not that income from walkable apartments and retail could not support their value. Rather, the problem may have been that less walkable options were posting even faster gains, reflecting the ascension of auto-oriented big box and power centers and more remote, auto-oriented but affordable apartments that allowed some relief from the overheated housing market.

Finally, we should note what our findings do not include. First, the value figures do not include a public cost-benefit analysis of walkability which would address externalities to public health, air quality, traffic safety, and energy conservation. Our results about walkable property values and investments in the marketplace do not address broader questions about the wisdom of promoting walkability as a matter of public policy. Second, our figures do not determine the relative profitability of more or less walkable property developments. We did not examine whether it costs more to develop walkable places and whether any such costs might exhaust the value premiums that we found. It seems possible, though, given the magnitude of the value premiums, that developers could profitably develop walkable properties. But any conclusions on this point must await the development of better information about the cost of developing such projects.

Investors, developers, policy makers and other stakeholders interested in more socially and environmentally responsible and sustainable property investing view walkability as an important goal for cities and property portfolios. Our finding that walkable properties do generate higher income than non-walkable properties suggests that tenants are willing to pay more to be at more walkable locations. Walkable properties are also equal or higher in value than less walkable ones. The higher value results from a higher income as well as investor willingness to purchase these properties at a lower cap rate. The lower cap rate suggests that investors thought that more walkable properties might have more growth potential or less risk than less walkable properties. As noted above, they may have paid too much of a premium for some property types during the period we analyzed. But the higher income and higher property value suggests that the private sector does recognize the value of walkability and there should be an incentive to develop such properties if the development costs (including land values) are not significantly greater. We might expect that some of the value resulting

from the higher income is capitalized into land values for more walkable properties and that some of the value is captured by the developers who choose to develop these properties.

Our findings for total returns from income and price appreciation were somewhat mixed over the period we analyzed. Private investors who purchased existing walkable office and warehouse properties earned a return that was not significantly different from non-walkable properties. In fact it was slightly higher for office properties.

For walkable retail properties, the price appreciation was less than for less walkable properties which we suspect may be due to growth during this period of big box retail which tends to be at less walkable locations. The lower price appreciation may suggest that the price premium for retail properties was adjusting during this period so that they would earn a market return going forward.

For walkable apartments, the price appreciation was not significantly lower but because a premium was paid (lower cap rate) for these properties, the total return was lower. This suggests that these properties were purchased in expectation of higher price appreciation, but the price appreciation was essentially the same as for less walkable properties resulting in a lower total return. It should be noted, however, that these properties may have been considered less risky and thus a lower total return would be justified.

All of the walkable property types including apartment and retail properties generate higher income and therefore have the potential to generate returns that are at least as good as less walkable properties as long as they are priced correctly and developers should be willing to develop more walkable properties as long as they don't have to pay too much of a premium for the more walkable locations and related development expenses.

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