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The Walkability Premium in Commercial Real Estate Investments

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This article examines 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. We use data from the National Council of Real Estate Investment Fiduciaries and Walk Score to examine the effects of walkability on the market value and investment returns of more than 4,200 office, apartment, retail and industrial properties from 2001 to 2008 in the United States. We found that, all else being equal, the benefits of greater walkability were capitalized into higher office, retail and apartment values. We found no effect on industrial properties. On a 100-point scale, a 10-point increase in walkability increased values by 1–9%, depending on property type. We also found that walkability was associated with lower cap rates and higher incomes, suggesting it has been favored in both the capital asset and building space markets. Walkability had no significant effect on historical total investment returns. All walkable property types have the potential to generate returns as good as or better than less walkable properties, as long as they are priced correctly. Developers should be willing to develop more walkable properties as long as any additional cost for more walkable locations and related development expenses do not exhaust the walkability premium.

Walkability has become a more prominent issue as urban planners, governments and public health leaders increasingly promote 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. Similar goals were endorsed by former U.S. Secretary of Health and Human Services Donna Shalala in her address to the Urban Land Institute in 2006 (Riggs 2006). Calls for more walkable cities can also be found

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in global policy discussions on global warming (Ribeiro *et al.* 2007, Ewing and Rong 2008, Marshall 2008).

In this article, we examine the impact of walkability on market values and investment returns for office, retail, apartment and industrial properties. In our analysis we use Walk Score, a new measure of walkability that is now widely available in the marketplace. We show how walkability fits our previous theory on property value determinants. We also contribute to a small but significant line of work on "local accessibility" and add to research on the economic consequences of land use mixing.

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 neotraditional subdivisions, turn-of-the-century streetcar suburbs (Southworth 1997), urban and suburban centers (Lang, Nelson and Sohmer 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. Environmental benefits may include less air pollution, auto use and gasoline consumption (Frank, Stone and Bachman 2000, Ewing and Cervero 2001, Frank and Engelke 2005). Social benefits could include greater physical activity (Doyle *et al*. 2006, Frank *et al.* 2006, Kerr *et al.* 2006, Pikora *et al.* 2006, Forsythe *et al*. 2007, Frank *et al*. 2007) and increased social capital including more community cohesion, political participation, trust and social activity (Leyden 2003, du Toit *et al.* 2007). These benefits remain a topic of ongoing research, though evidence supporting them is emerging from well-controlled studies (Handy, Cao and Mokhtarian 2005, Cao, Handy and Mokhtarian 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 multidimensional construct composed of different factors that 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, Handy and Mokhtarian 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 (1993) calls "local accessibility" that 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 $\frac{1}{4}$ 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 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 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 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 well 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 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 biophysical) and public-sector factors (taxes and services).[1]

[1]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,

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 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 article, 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

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Hoag 1980, Guntermann and Norrbin 1987, Glascock, Jahanian and Sirmans 1990, Sirmans and Benjamin 1991, Mills 1992, Ambrose 1990, Sirmans and Guidry 1993, Asabere and Huffman 1996, Kim and Nelson 1996, Benjamin, Sirmans and Zietz 1997, Buttimer, Rutherford and Witten 1997, Sivitanides 1998, Frew and Jud 2003 and Rosiers, Theriault and Menetrier 2005.

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 4–15% premium that 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 $\frac{1}{4}$ mile of commercial uses and bus stops, density, mixed use, circulation system design and the availability of nonauto 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, Theriault and Menetrier (1996) found that the distance to primary schools and shopping centers were inversely related to rents. Except for Mills' work, we do not know 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 by itself, 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 those can reduce residential values.

Some prior empirical work found no evidence that land use mixing affects property values (Crecine, Davis and Jackson 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 property 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, Gujral and Coley (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 nonresidential 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 dis-amenities effects may begin to dominate. The other is that some nonresidential 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 nonresidential 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 incomes and values. But properties that 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 Dijk 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 that may not have been anticipated by the 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 autooriented 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 nonpartisan 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 United States.

NCREIF has information on the financial performance, physical features and location of office, hotel, apartment, retail, industrial and other properties. Properties owned by contributing members are included in the pool, and they are 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, when the data set was established, until the present because they were not held for the 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 2001 to 2008 and had complete addresses. Addresses were needed so we could obtain geocodes, which were needed to obtain information from other data sources (discussed further below). That came to a total of 4,237 properties with a market value of over $211 billion. We obtained Walk Score ratings from Front Seat for each of these locations.

Because the data set increases in the quarter a new property is acquired (or a new member joins NCREIF and starts contributing) and data are no longer available in quarters after a member sells a property to a nonmember, our data set varied for any given quarter. Altogether, we had 44,169 observations with Walk Score ratings.

In order to understand how well our final data set represented all U.S. commercial properties, we compared the final sample to data from the U.S. Energy Information Administration (EIA) Commercial Building Energy Consumption Survey (CBECS), which estimates the number of commercial buildings in the nation by region and type. Excluding apartments, which were also in our data set, the distribution of our sample by region and by property type fell within the 95% confidence intervals for the estimates for the entire U.S. commercial building stock generated by the EIA from CBECS. Nonetheless, when we compared our sample of commercial buildings to the CBECS population estimates, our sample was overweighted toward industrial properties, overweighted toward western properties, and under weighted toward all other types and regions. To address any bias this may have introduced in our results, we conducted separate analyses by property type. We also tested the robustness of our results by running separate analyses by region, property value and regional walkability. One bias we could not check the sample for was financial performance. If NCREIF members drop low performing properties from their portfolios, then our sample would be biased toward higher performing properties. And if the effects of walkability covary with property performance, this could limit the ability to generalize our findings to properties that do not perform to institutional standards. This could put some limitation on the external validity of our study, but it would not affect its internal validity since it would not change any relationships we observe between walkability and our dependent variables.

We used ordinary least squares (OLS) regression analysis to test our hypotheses. Because the sample had characteristics of an incomplete panel, we also used the random effects panel regression model, which is discussed further under Robustness Checks. Table 1 gives definitions and summary statistics for the variables used in the study.

Walk Score

The walkability measure used in the study was Walk Score. It rates 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 nearest destination of each type using Google Maps. If the closest establishment of a certain type is within one-quarter mile, Walk Score assigns the maximum number of points for that type. The number of points assigned declines as the distance approaches one mile, and no points are awarded for destinations further than one mile. Each type of destination is weighted equally and the points assigned to each category are summed and normalized to yield a score from 0 to 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 property types whose values are most sensitive to the locational advantages, amenities and services that walkability provides its occupants. So we expected walkability would be most beneficial for apartments and offices. For industrial properties, we thought there could be a negative effect because of the desire to avoid conflicting land uses and pedestrian activity. For retail properties, the outcome seemed less clear. Higher Walk Score could mean more competition, but it could also mean more foot traffic and agglomeration economies.

Three limitations of Walk Score should be noted. First, it weights all destinations equally. Lee and Moudon (2006) found, however, that out of the 24 destinations they studied, only groceries, schools, banks, restaurants and bars were significantly associated with home-based walking. Walk Score does not count banks. It is also possible for a property to have a relatively high Walk Score without being close to what Lee and Moudon (2006) found were the most significant destinations. Second, it uses broad definitions for each type of destination. For instance, it gives equal value to both full service and limited service grocery stores, when they could have very different effects on walking and property values. Third, it does not account for other factors that have been empirically or theoretically linked to walkability. The most notable is connectivity.

Table 1 ■ Variable definitions and summary statistics.

Variable	Definition	Obs.	Mean	St. Dev.	Min.	Max.
WALK SCORE	Walkability index based on distance to desired destinations.	47,263	60.17	22.90	0	100
VALUE	Value of the property at the end of the quarter.	47,262	43,500,000	77,500,000	209,850	1,730,000,000
NOI	Net operating income per square foot	45,946	2.48	2.27	0.00	48.33
INCRET_QTR	Mean income return for the current and prior three quarters.[a]	47,263	0.017	0.012	−0.34	1.66
APPRET_QTR	Mean capital return for the current and prior three quarters.	47,263	0.011	0.19	−10.75	27.82
TRET_QTR	Mean total return for the current and prior three quarters.	47,263	0.028	0.19	−10.84	27.91
REG_EMP	Nine-quarter moving average employment growth rate in the CBSA, expressed annually.	49,987	1.68	2.23	−8.73	25.64
SUPPLY	Nine-quarter moving average office building growth rate in the CBSA, expressed annually.	59,898	1.94	2.14	0	29.02
OCC_CBSA	Average occupancy rate for the property type in the CBSA for the quarter.	47,263	0.91	0.58	0.02	1.00
RET_CBSA	The average quarterly total return in the CBSA for all property types in the current and prior three quarters.	47,263	0.027	0.052	−0.97	0.92
NPITOTRET	Quarterly return for all properties in the NCREIF Property Index.	47,263	0.024	0.029	−0.083	0.055
AGE	Age of the property (years).	43,219	18.60	15.21	0	124
SQFT	Size of the property (square feet).	47,263	277,288	329,086	5,858	2,260,000

Table 1 ■ Continued.

Variable	Definition	Obs.	Mean	St. Dev.	Min.	Max.
FLOORS	Number of stories.	47,263	3.30	6.60	0	76.0
FLOORS2	Number of stories squared.	47,263	54.6	253.1	0	5,776
PROPCRIME	Property crimes in city per 100,000 persons.	38,487	4,589.6	5,187.1	353.9	150,000
PROPTAX	Four-quarter moving average property tax per $ of property value (in dollars) at the CBSA level.	46,704	0.014	0.005	0.000	0.066
BGPOPDEN	Census block group population density in persons per square mile in 2007.	47,263	5,405.3	14,464.9	0	226,900
TRANSITHALF	A dummy variable where 1 = within half mile of a fixed rail transit station.	47,263	0.14	0.34	0	1
TRAVHOMEWORK	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.	46,875	25.17	5.68	0	71
MSADEN	Persons per square mile of land area in the city or census designated place.	50,633	939.74	1,065.32	6.81	6,683.03

[a]The income return we report is quarterly. The mean should be multiplied by four to get an annual value. The annual value is analogous to the cap rate.

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,[2] 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 to be 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 Schofer (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.

Other caveats should also be mentioned to prevent misinterpretation of the results. 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 14 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, Moudon and Logsdon 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 greater walkability 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 walkability premium 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 easily drive or bicycle to nearby destinations. Nonetheless, the fact that walkability may produce accessibility benefits for nonwalkers does not diminish the validity of any 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. Third, for retail properties, walkscore does not differentiate between enclosed malls, shopping centers and freestanding retail outlets. A retail property in a mall

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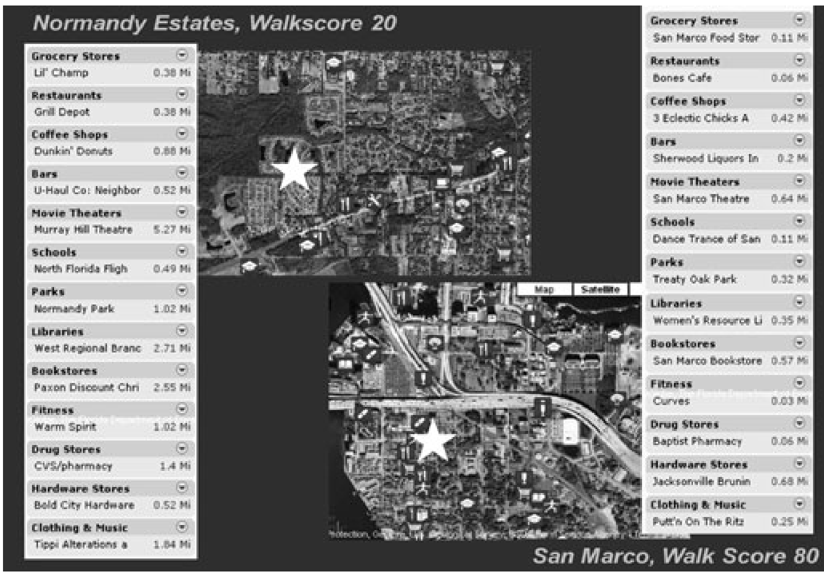
[2] A new version of Walk Score will take connectivity into consideration.

Figure 1 ■ A comparison of two neighborhoods in Jacksonville, Florida, with low and high Walk Scores.



could have the same Walk Score as a freestanding retail property, depending on its proximity to other services. And fourth, Walk Score does not differentiate between whether an address is a residence, workplace, retail outlet or other use. High walkability from a residence implies the potential for a relatively car-free lifestyle while high walkability from an office building or retail outlet does not because it may still require pedestrians to travel to the location from their home, and that could require other travel modes. Walk Score does not account for the distance to housing and as such is dissimilar from concepts such as jobs-housing balance, retail-housing balance or urbanism, which imply a mix of housing, jobs, shopping and other daily needs all located in close proximity to one another.

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 presented that list 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 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 will help the reader understand the difference between these scores.

Financial variables

Data for whole buildings were provided by NCREIF on net operating income, market value and quarterly investment returns. Actual accounting data were available for net operating income. Appraised values were available for the properties that had not sold and transaction prices for properties that had sold—the same appraisals and transaction prices used to calculate the quarterly NCREIF Property Index. Many studies have shown that appraised values tend to lag transaction prices by a quarter or two in appraisal-based indices. One reason for this is the nature of the appraisal process, which relies on historical data such as comparable sales. Another reason is that not all properties are actually revalued every quarter. Some may only be revalued two or three times a year. However, virtually all of the properties are revalued at least once a year. Since the purpose of this study was to examine cross-sectional differences in property values as a result of different RPI characteristics, a delay of a quarter or two in updating the appraised value of a particular property did not significantly impact the relative cross-sectional differences in properties. Said differently, since properties with and without a particular RPI characteristic have the same appraisal lag, the cross-sectional comparisons are on an apples-to-apples basis.

The log of the end of quarter market value was used in the market value regressions. Return variables were based on the average compound return over the current and prior three quarters. The log of 1 + return was used in the return regressions because the values could be negative. 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* that measures the change in market value from one period to the next and *Total Return* that is computed by adding the *Income Return* and the *Capital Return*. Appendix A provides a more detailed description of the return variables.

It should be noted that bias associated with appraisal smoothing at the individual property level is different from that at the index level. There are "unsmoothing techniques" that can be applied at the index level to account for the fact that not all properties are revalued every quarter. However, this is not appropriate for individual properties. The problem caused by individual properties not being revalued every quarter is that in those quarters the property is not revalued, there will be no change in value and the return is biased toward zero. Furthermore, when there is a revaluation, the return will reflect all the change in value since the last appraisal. Virtually all properties in the index are revalued at least once a year. Thus, we use a four-quarter moving average of returns as our dependent variable. This allows us to better capture the trend in returns than using single quarter returns. Each quarter will reflect how values have changed on average over the past four quarters rather than having some quarters with no change in value and others with a too high (or too negative) change in value that reflects more than one quarter. Because quarterly returns will tend to be correlated over time, we used a panel regression with clustering at both the property and year level as a robustness test to be sure the independent variables of interest were still significant and we found they were.

Control Variables

Prior studies on urban land values and investment returns have identified a variety of correlates. In order to isolate the effects of walkability, we introduced controls for many of them. To identify necessary controls we reviewed 35 published papers that model rent, value or returns for various property types. We cite many of them under Walkability as a Determinant of Urban Land Values. There is a good deal of variation in the controls used in the literature, but most fall into five dimensions: market conditions, physical building characteristics, neighborhood conditions, local taxes and services and accessibility. More rarely, owner, renter, lease and property management characteristics are included. For this study, we used one or more controls from each of the five common dimensions.

The NCREIF market index was used to control for market conditions. As noted, appraisal smoothing was not an issue 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. Growth of the regional building stock (for each property type) was used as a measure of local supply. Regional occupancy rates were used to control for the balance between supply and demand. We also used a regionally disaggregated NCREIF market index as a substitute for regional occupancy rates but they produced similar results (see Robustness Checks). Dummy variables were used to control for regional location. We tried both CBSA and State dummy variables and found that state controls produced better though similar results. Any factor not otherwise controlled and which varied systematically by state was controlled by the state dummies. This includes climate and demographics, which could affect the degree to which walkability is valued by building users. Building size, stories and age data from NCREIF were used to control for physical building characteristics. Property crime rates at the city-level published by the U.S. Department of Justice for 2006 were used to control for neighborhood conditions. Effective tax rate paid by each property was computed from NCREIF tax expenditure and property value data. The mean rate at the CBSA level was used to control for local taxes and 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 $\frac{1}{2}$ 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 2007 population density in the block group where each study property was located. Transit station locations were obtained from the U.S. Bureau of Transportation Statistics and Google Earth, journey-to-work times were obtained from the 2000 U.S. Census Transportation Planning Package and density was obtained from the U.S. 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 van Wee 2004). Nevertheless, Levinson (1998) has demonstrated that journey-to-work time is a good proxy for gravity-based accessibility measures, and, according to Heikkila and Peiser (1992), accessibility depends on urban density. We also controlled for regional congestion and mobility levels by using CBSA density, which we found to be a good proxy for more specific congestion measures that are not available for all the regions studied.

A caveat that should be mentioned is that we did not control for variations in the local policy environment that could be correlated with walkability. It is possible that the local policy environments that produce walkable developments could also produce higher prices for reasons other than walkability. If that is true, then an observed value for walkability could also be indicating something about the local policy environment that is correlated with walkability. This should be kept in mind when interpreting the results.

Regression Models

OLS regression models were used to test our hypotheses. We used log transformed dependent variables to reduce skewness and facilitate interpretability of the coefficients. All models were of the following form:

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

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. Since our focus was on the relationship between walkability and economic outcomes, we were primarily concerned with the coefficient and significance for Walk Score and control variables that could be affecting its relationship with the dependent variable. The R^2 values were of secondary importance as the models were not developed for predictive purposes.

Table 2 gives the correlations among the regressors. None were strongly correlated indicating a lack of multicollinearity problems.

Analysis and Results

Market Value

Table 3 presents our results for market value. In every model but industrial, the coefficient for Walk Score was positive and significant. A one-unit increase in Walk Score produced a 0.9%, 0.9% and 0.1% value premium for office, retail and apartment properties, respectively. All else being equal, an office property with a Walk Score of 80 was worth 54% more per square foot than an office with a 20 Walk Score. For retail and apartment properties, 80 Walk Score properties were worth 54% and 6% more, respectively.

As noted, we used log-transformed market value in our models, which is the standard with hedonic regressions. We ran the models without the log and the results were virtually the same.

We were unsurprised to find no walkability premium for industrial properties. Most of the industrial properties in the data set were warehouses, and the nonindustrial uses and pedestrians associated with walkability probably conflict with the trucks, trains and noises typical of warehouse districts.

It was also interesting to find that walkability had a relatively small positive effect on apartment properties. As noted above, prior research has found both positive proximity and negative disamenity effects on residential property values from nearby nonresidential uses, with the disamenity effects increasing as nonresidential uses get closer to homes. Our findings suggest that these mixed effects could well have been present in our data set, especially since the Walk Score protocol assigns the highest score to apartments with the most types of nonresidential uses within $\frac{1}{4}$ mile. In these circumstances there could be insufficient distance between the apartments and nonresidential uses to fully extinguish negative externalities. We suspect the reason we did not see this effect in the other uses was that the noise, traffic, security and other disamenities from nonresidential uses may have more disutility for apartment dwellers

Table 2 ■ Correlations among the regressors.

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. *WALKSCORE*	1														
2. *REG_EMP*	−.11	1													
3. *SUPPLY*	.04	.09	1												
4. *OCC_CBSA*	−.04	.25	−.15	1											
5. *NIPTOTRET*	.00	.02	−.44	.11	1										
6. *AGE*	.25	.09	−.17	−.01	.08	1									
7. *SQFT*	.07	−.01	−.02	.00	−.03	.08	1								
8. *FLOORS*	.46	−.01	.07	−.14	−.03	.10	.24	1							
9. *FLOORS2*	.32	−.08	.04	−.08	−.01	.06	.27	.89	1						
10. *POPCRIME*	−.04	.09	.09	−.02	.01	−.02	.04	−.02	.01	1					
11. *PROPTAX*	−.03	−.14	.09	−.13	−.17	−.06	.02	.08	.04	.09	1				
12. *BGPOPDEN*	.35	−.09	.03	.07	.00	.14	.04	.36	.25	−.14	−.01	1			
13. *TRANSITHALF*	.51	−.15	−.02	−.04	.02	.24	.11	.46	.31	−.05	.04	.39	1		
14. *TRAVHOMEWORK*	−.19	.01	−.07	.14	.01	−.05	−.01	−.13	−.18	−.21	−.15	.04	−.01	1	
15. *MSADENS*	.33	.19	−.16	.11	.02	.25	.05	.25	.17	−.39	−.12	.51	.3	.18	1

Table 3 ■ Regression results for log of market value.

	All Types	Office	Retail	Apartments	Industrial
WALK SCORE	0.011***	0.0091***	0.0089***	0.0012**	0.00087
Market conditions					
REG_EMP	0.050***	0.018***	0.056***	0.062***	0.035***
SUPPLY	0.052***	−0.038**	−0.12	0.028**	0.036*
OCC_CBSA	1.30***	1.68***	2.80***	−0.50*	−0.41*
NPITOTRET	9.06***	8.91***	10.02***	10.71***	3.35***
STATE	Not Shown	Not Shown	Not Shown	Not Shown	Not Shown
Physical building characteristics					
AGE	−0.011***	−0.011***	−0.0012	−0.017***	−0.011***
SQFT	1.37e-06***	6.83e-07***	2.06e-06***	1.56e-06***	1.77e-06***
FLOORS	0.063***	0.043***	−0.060*	0.032***	0.19***
FLOOR2	−0.00082***	−0.00026***	0.023***	−0.000***	−0.13***
Neighborhood conditions					
PROPCRIME	−0.000051***	−8.25e-07	4.67e-06	−0.000025***	−0.000048***
Local taxes and services					
PROPTAX	−30.56***	−58.45***	5.52	−22.49***	5.83
Accessibility					
BGPOPDEN	−4.11e-07	5.33e-08	7.36e-06**	1.18e-06*	3.46e-06
TRANSITHALF	0.18***	0.18***	0.29***	0.086***	0.28***
TRAVHOMEWORK	−0.0058***	−0.0018	0.002	−0.011***	−0.014***
MSADEN	0.041***	0.18***	0.01	0.20***	0.099***
n	20,638	6,343	2,174	4,637	7,484
R^2	58%	57%	73%	63%	65%

Note: *, ** and *** indicate significance at the 5%, 1% and 0.1% levels, respectively.

than for the users of the other property types. It appears, however, that any disamenity effects did not fully offset the positive proximity effects from walkability on apartments. On net, walkability was associated with higher apartment values.

Nearly all controls had the expected signs and most were significant. *FLOORS* was not significantly positive in the retail model, but there may well be economic disadvantages to shopping centers with more than two or three stories due to functionality and convenience issues (Brown 1999).

Net Operating Income

Table 4 presents our results for net operating income (NOI). Since property values are normally a function of the income they produce, we expected higher market values to be associated with higher incomes. That is what we found for office and retail, but not for apartments. For each one-unit increase in Walk Score, we found that NOI was 0.7% higher for office and retail properties. For apartments, there was no significant difference. There was also no difference for industrial, consistent with our market value findings.

Comparing properties with 80 and 20 Walk Scores, NOI per foot would be 42% higher for office and retail and no different for apartments. For each of these types, the NOI results could not fully explain the higher values. However, as we will see in the next section, an additional portion of higher market values can be explained by lower cap rates, which increase value independent of NOI.

Return on Investment

Table 5 gives the results for appreciation, income and total returns for all properties types combined. The models had low R^2 values, but as stated above this was not a concern since the models were not developed to make predictions, but rather to examine the relationships between Walk Score and the dependent variables.

A one-point increase in Walk Score increased the appreciation rate by two basis points and reduced income returns by 0.7 basis points. Income return is analogous to the cap rate, so in effect investors were willing to accept a 0.007% lower cap rate and pay 0.007% more per dollar of income for each unit increase in Walk Score. For an 80 versus 20 Walk Score property this converts into 1.2% faster appreciation per quarter and a 0.42% lower cap rate.

Total return is the sum of appreciation and income returns. According to the third model, for every one-unit increase in Walk Score, total returns increased by 1.3 basis points, which as it should be, is equal to the sum of the Walk

Table 4 ■ Regression results for log of net operating income.

	All Types	Office	Retail	Apartments	Industrial
WALK SCORE	0.010***	0.007***	0.007***	1.67e-06	0.001
Market conditions					
REG_EMP	0.029***	−0.007	0.034***	0.057***	−0.003
SUPPLY	0.072***	−0.008	0.027	0.022*	0.13***
OCC_CBSA	1.47***	2.40***	5.09***	0.32	−0.06
NPITOTRET	0.25	−0.82	1.96	2.69***	−3.66***
STATE	Not shown	Not shown	Not shown	Not shown	Not shown
Physical building characteristics					
AGE	−0.011***	−0.012***	−0.003***	−0.018***	−0.013***
SQFT	1.34e-06***	6.52−07***	2.14e-06***	1.56e-06***	1.75e-06***
FLOORS	0.059***	0.040***	−0.031	0.025***	0.19***
FLOORS2	−0.001***	−0.000***	−0.015***	−0.003**	−0.12***
Neighborhood conditions					
PROPCRIME	−0.000037***	0.000025**	−4.48e-06	−0.000028***	−0.000041***
Local taxes and services					
PROPTAX	−24.66***	−42.09***	−4.46	−17.97**	3.02
Accessibility					
BGPOPDEN	−1.65e-06**	2.05e-06	3.99e-06	1.47e-06**	6.10e-06
TRANSITHALF	0.14***	0.16***	−0.36***	0.03	0.19***
TRAVHOMEWORK	−0.005***	0.004	−0.006	−0.015***	−0.012***
MSADEN	0.039**	0.12***	0.026	0.18***	0.13***
n	20,048	6,112	2,140	4,588	7,208
R^2	47%	41%	64%	52%	53%

Note: *, ** and *** indicate significance at the 5%, 1% and 0.1% levels, respectively.

Table 5 ■ Regression results for return measures for all types.

	Appreciation	Income	Total
WALK SCORE	0.00020**	−0.00007***	0.00013
Market conditions			
REG_EMP	0.012***	−0.0015***	0.011***
SUPPLY	−0.016***	0.0018***	−0.014***
NPITOTRET	2.47***	−0.43***	2.00***
OCC_CBSA	0.31***	−.0013	0.31***
STATE	Not shown	Not shown	Not shown
Physical building characteristics			
AGE	−0.00025**	6.13-06	−0.00024**
SQFT	5.81e-09*	5.25e-10	6.24e-09*
FLOORS	0.00014	−0.00005	0.00011
FLOORS2	9.59e-07	−3.98e-07	2.11e-07
Neighborhood conditions			
PROPCRIME	−5.12e-07	3.50e-07*	−1.86e-07
Local taxes and services			
PROPTAX	−4.45***	0.86***	−3.59***
Accessibility			
BGPOPDEN	1.46e-07	−5.66e-08**	8.36e-08
TRANSITHALF	0.01**	−0.0040***	0.0067
TRAVHOMEWORK	−0.00042*	−0.000096	−0.00053*
MSADEN	0.0014	−0.00036	0.0011
n	14,603	14,605	14,603
R^2	0.16	0.08	0.13

Note: *, ** and *** indicate significance at the 5%, 1% and 0.1% levels, respectively.

Score coefficients in the appreciation and income return models. However, the Walk Score coefficient in the total return model was insignificant suggesting that higher appreciation and lower income returns offset one another, resulting in a statistically neutral effect on total returns.

We used the same controls in the return models as we did in the market value and NOI models. We only expected the regional and national economic variables (REG_EMP, SUPPLY, NPITOTRET, OCC_CBSA) to be significant, but we included all the controls to demonstrate that the Walk Score coefficients were not erroneously inflated from an underspecified model. As expected, the economic controls were significant and had the expected signs. Most other controls did have signs that were plausible and significant in many instances. The most significant effects among these were from property tax rates, which increased cap rates and lowered appreciation and total returns.

Similar models were produced separately for each type of property. Table 6 gives the Walk Score coefficients from these models. For appreciation and

Table 6 ■ Walk Score effects on returns by property type.

	Office	Retail	Apartments	Industrial
Appreciation	0.00032*	0.000071	−0.000049	0.000082
Income	−0.000052	−0.00012**	−0.000091***	−0.000024
Total	0.00027	−0.00018	−0.00014	0.000056

Notes: *, ** and *** indicate significance at the 5%, 1% and 0.1% levels, respectively.

income returns, the results for separate property types were not as clear-cut as in the All Types models. Walkability did not significantly affect appreciation returns, except in Offices, where the effect was positive. Apparently, some of the higher value associated with walkable offices was first capitalized during the study period. For retail and apartments, on the other hand, the walkability premium must have been priced into the market prior to the study period. Meanwhile, walkability significantly lowered income returns for retail and apartments but not for offices and industrial. The results for total returns by property type were consistent with the All Types model, indicating that walkability did not significantly change total returns. Overall, these results indicate that walkability neither diluted nor inflated total returns over the past decade.

The lower-income returns and cap rates help explain the higher market values that cannot be fully explained by higher NOI. Recall, for example, that retail properties had 0.9% higher market values and 0.7% higher NOI for each additional unit of Walk Score. Holding risk constant, a higher NOI should produce an equivalent effect in percentage terms on market value. However in this case, there was an additional value increment over and above what can be explained by higher NOI and that additional increment can be explained by lower cap rates. In fact, the combination of an NOI that is 0.7% higher than the mean for our data set and a cap rate that is 0.012% lower than the mean in the data set increases the value of a hypothetical property by 0.9%, which is precisely the value premium that we found. So it appears that the higher retail value associated with higher Walk Score values can best be explained by a combination of the higher NOI and the lower cap rates that were observed in the data. The same is true for Apartments. Apartment NOI was not increased by walkability but market value was. Again, the difference can be explained by the lower cap rates we found using the Apartment income returns model. The Walk Score coefficient in the Office income returns model was insignificant. However, if it were correct, it would be large enough to explain half the walkable office market value premium that could not be explained by higher NOI. So, generally, the data appear to support the proposition that the walkability premium is driven by a combination of higher NOI and lower cap rates.

Robustness Checks

We tested the robustness of our results by producing models for various subsets of our data.

First, we separated the data by the four NCREIF regions and produced models that included all property types using the same regressors as in our original models. The Walk Score coefficients for the market value and NOI models were significant for all regions and nearly identical to the coefficients for our original All Types models given in Tables 3 and 4. We also found no significant effect from walkability on total returns for the East, West and South, which is what we found when all regions were examined together. However, total returns were significantly higher for more walkable properties in the Midwest due to significantly higher appreciation returns. In the Midwest, a one-point increase in Walk Score increased appreciation by 0.5 basis points, which converts to 0.3% faster appreciation per quarter for an 80 versus 20 Walk Score. So in general, the effect of walkability on Value, NOI and total returns were similar for all regions except for the Midwest where its effect on total returns was significantly positive.

We also separated each type of property into those above and below the median value for their type and combined all the properties into two groups, one with above-median-valued properties and one with the below-median-valued properties. Each group contained the same share of each type as in our original All Types models. We then produced models for value, NOI and returns, again using our original regressors, to see if walkability had different effects on more or less valuable properties. In all the regressions Walk Score had significant coefficients with the same signs as in our original models but with larger absolute value in the more valuable properties. For example, the coefficients for value and NOI were 0.008 and 0.007 in the higher value properties model but only 0.002 and 0.001 in the lower value one. The effects on appreciation and total returns were very similar in each case, but the effect on income returns/cap rates was larger for higher-valued properties (−0.00006 vs. −0.00005). This test could indicate that walkability is a superior good, but nonetheless it remained significant when tested separately on higher- and lower-valued properties.

Finally, we created separate All Types models for the most and least walkable cities, as determined by Front Seat using the Walk Scores for all properties in each city. The most walkable cities were New York, Boston, San Francisco, Washington D.C., Chicago and Philadelphia. The least were Jacksonville, Nashville, Charlotte, Indianapolis, Oklahoma City, Memphis, Fort Worth, Kansas City, San Antonio, El Paso, Austin and Phoenix. The Walk Score value coefficients were significantly positive in both models, though

Table 7 ■ Walk Score effects in panel and OLS models for all property types.

	Panel Regression	OLS Regression
Market value	0.0078***	0.011***
NOI	0.010***	0.010***
Appreciation	0.00011	0.00020**
Income	−0.000017	−0.000067***
Total	0.000059	0.00013

Notes: *, ** and *** indicate significance at the 5%, 1% and 0.1% levels, respectively.

larger in the Least Walkable model than in the Most Walkable model (0.010 vs. 0.009). The same was true for NOI (0.010 vs. 0.008). Perhaps there is an additional premium for walkability in the less walkable regions. For investment returns, walkability had no significant effect on total return in both groups, as we found for all cities taken together (Table 5). The result for income returns (cap rate) was notable. In our original model we found a significantly negative coefficient (lower cap rate) for Walk Score. We found a similar result in the most walkable cities, but no significant effect in the least walkable ones. It appeared that the walkability premium in the most walkable cities was attributable to a combination of higher NOI and a lower cap rate, while in the least walkable cities the walkability premium could be fully explained by a higher NOI and investors seemed unwilling to accept a different cap rate for more walkable properties. Overall, our findings held up and were very similar in the most and least walkable places.

Because the data had characteristics of an unbalanced panel, we also tested our hypotheses using the random effects panel regression model. It controls for omitted variables that differ between cases but are constant over time and for omitted variables that may be fixed between cases but vary over time. As shown in Table 7, the Walk Score coefficients in all the panel models were very similar to those found with the general multiple regression models, though slightly smaller in most cases. For income and appreciation returns, the coefficients were smaller but in the same direction.

One final concern we had was to be sure that the results were not artifacts of any differences in real estate trends that might have existed across regions. For example, we wanted to be sure that the return results were not driven by having the more walkable cities appreciate slower or faster than the less walkable cities. We could accomplish this by using a metropolitan-scale NCREIF return index in the models. However, since national trends in occupancy rates and the NCREIF index have been historically correlated, we thought that CBSA_OCC would control for year-to-year differences in returns at the metropolitan level as well. However, to be sure, we replaced CBSA_OCC with the NCREIF return index disaggregated to the metro scale in our All Types models. The change had virtually no effect on the value, NOI and return models, except the Walk Score coefficient was slightly lower in the income return model (−.00007 vs. −.00005), which only served to strengthen our initial findings.

Summary and Conclusion

We hypothesized that walkable properties had incomes 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 data for over 4,200 properties of various types from throughout the United States. Table 8 summarizes our results and shows that our hypotheses were mostly confirmed.

Walkability was associated with higher value for office, retail and apartment properties. These types of properties with a Walk Score of 80 were worth anywhere from 6% to 54% more than properties with a 20 Walk Score, depending on property type. Consistent with their higher values, we also found higher net operating incomes for the office and retail properties.

Walkability did not have a statistically significant effect on total returns. We did see, however, lower cap rates for more walkable retail and apartment properties. Apparently, investors were willing to pay more for each dollar of income produced by more walkable retail and apartment properties either because they viewed them as safer investments or because they anticipated superior income growth or slower depreciation.

Finally, we should note what our findings do not include. First, the value figures do not include a public cost-benefit analysis of walkability that would address externalities to public health, air quality, traffic safety and energy conservation. As such, our results do not address the advisability 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 could not examine whether it costs more to develop walkable places and whether any such costs might exhaust the value premiums that were found. However, given the magnitude of the value premiums, it seems plausible that developers could profitably develop walkable properties. But any conclusions on this point must await the development of better information on the cost of developing in more walkable locations.

Planners, health experts and others have been promoting the benefits of more walkable cities. But investors and developers may worry that insufficient financial performance could be an obstacle. We find no evidence, however, to

Table 8 ■ Summary of results for 80 versus 20 Walk Scores.

Property Type	*Market Value*	*NOI*	*Appreciation* (Per Quarter)	*Income Return* (Per Quarter)	*Total Return* (Per Quarter)
Office	+54%***	+42%***	1.92%*	–	–
Retail	+54%***	+42%***	–	−0.72%**	–
Apartments	+6%**	–	–	−0.54%***	–
Industrial	–	–	–	–	–

Notes: *, ** and *** indicate significance at the 5%, 1% and 0.1% levels, respectively.

support this concern. Rather, it appears that over the past several years walkable properties have performed on par with other property investments and could be superior investments for developers if they can manage to capture some or all of the walkability premium that appears to exist in the U.S. property market.

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Appendix A

The following description of the NCREIF properties and measures comes from material published by NCREIF on its website. More details are available at www.ncreif.org.

The qualifications for inclusion in the NCREIF data set are:

- Operating properties only.
- Property types—apartments, hotels, industrial properties, office buildings and retail only.
- Can be wholly owned or in a joint venture structure.
- Investment returns are reported on a nonleveraged basis. While there are properties in the NPI that have leverage, returns are reported to NCREIF as if there is no leverage
- Must be owned/controlled by a qualified tax-exempt institutional investor or its designated agent.
- Existing properties only (no development projects).

An Operating Property is defined as follows:

a) For a newly developed property, operating is defined as reaching 60% occupancy or having been available for occupancy for a year from its certificate of occupancy (CO).

b) If a property has been recently purchased with a "redevelopment" strategy, and if the property is undergoing substantial expansion or retenanting, rehabilitation, or remodeling, the property is defined as operating when occupancy reaches 60%.

c) All existing properties (not recently developed or undergoing redevelopment as covered in a) or b) above) that are purchased regardless of current occupancy are defined as operating properties.

Two sets of data are collected. The first represents property-specific descriptor information submitted when a property enters the database for the first time. The second data set is collected quarterly and includes the components of return needed to calculate quarterly rates of return and index values. NCREIF collects considerably more data than what is required to calculate the NCREIF Property Index (NPI). Additional data are used in NPI data validation tests, to calculate additional statistical measures of performance, to develop operating benchmarks and for use in real estate research. Data are submitted in accordance with NCREIF's data submission manual, NCREIF Property Indexes Data Collection and Reporting Procedures. The data NCREIF collects originate from the accounting and property management systems of Data Contributors.

NCREIF requires that properties included in the NPI be valued at least quarterly, either internally or externally, using standard commercial real estate appraisal methodology. Each property must be independently appraised a minimum of once every three years. Because the NPI is a measure of private market real estate performance, the capital value component of return is predominately the product of property appraisals. As such, the NPI is often referred to as an "appraisal based index."

The NPI quarterly, annual and annualized total returns consist of three components of return—income, capital and total.

The *Income Return* measures that portion of total return attributable to each NPI property's net operating income. Net operating income (*NOI*) is gross rental income plus any other income less operating expenses—utilities, maintenance, taxes, property management, insurance, *etc*. The income return is computed by dividing *NOI* by the average daily investment for each quarter. The formula takes into consideration any capital improvements and/or any partial sales that occurred during the quarter.

$$\frac{\text{NOI}}{\text{Beginning Market Value} + 1/2\text{Capital Improvements} - 1/2\text{Partial Sales} - 1/3\text{NOI}}$$

The *Capital Return* measures the change in market value from one period to the next. A property's value can go up (appreciation) or it can decline (depreciation) depending on market forces. The formula takes into consideration any capital improvements and/or any partial sales that occurred during the quarter. When a property enters the Index, the capital return is not impacted until the second quarter of inclusion.

$$\frac{(\text{Ending Market Value} - \text{Beginning Market Value}) + \text{Partial Sales} - \text{Capital Improvements}}{\text{Beginning Market Value} + 1/2\text{Capital Improvements} - 1/2\text{Partial Sales} - 1/3\text{NOI}}$$

Total Return is computed by adding the *Income Return* and the *Capital Value Return*.