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Impact of Proximity to Light Rail Rapid Transit on Station-area Property Values in Buffalo, New York

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Summary. This study assesses the impact of proximity to light rail transit stations on residential property values in Buffalo, New York, where light rail has been in service for 20 years, but population is declining and ridership is decreasing. Hedonic models are constructed of assessed value for residential properties within half a mile of 14 light rail stations and independent variables are included that describe property characteristics, neighbourhood characteristics and locational amenities. The model suggests that, for homes located in the study area, every foot closer to a light rail station increases average property values by $2.31 (using geographical straight-line distance) and $0.99 (using network distance). Consequently, a home located within one-quarter of a mile radius of a light rail station can earn a premium of $1300–3000, or 2–5 per cent of the city's median home value. Model results further suggest that three independent variables—the number of bathrooms, size of the parcel and location on the East side or West side of Buffalo—are more influential than rail proximity in predicting property values. Individual regression models for each of the light rail system's 14 stations suggest that effects are not felt evenly throughout the system. Proximity effects are positive in high-income station areas and negative in low-income station areas. An analysis of the actual walking distance to stations (along the street network) versus the perceived proximity to stations (measured by straight-line distance) reveals that the results are statistically more significant in the network distance than the straight-line distance model, but the effects are greater in the straight-line distance model, which suggests that apparent proximity to rail stations is an added locational advantage compared with physical walking distance to the station.

Introduction

The relationship between a transit system, the location of transit stations and property values are, in theory, fundamental to land markets and urban structure. This is because public transit provides access to central business districts, employment locations, healthcare, schools and colleges and entertainment and recreation, and thereby increases accessibility to an entire region through which a transit system traverses. Transit stations are the points of access to a transit system and the ability to access them conveniently and quickly influences property values. Conventional urban economic theory—derived from utility maximisation—suggests a relationship between improvements to transport systems

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and the value of property; in other words, residential property values rise with decreasing distance to a transit station and with decreasing distance to the central business district (Alonso, 1964). Herbert Mohring (1961, p. 244) argues that "the basic value of an investment—be it in highway or anything else—is the value of the resources it releases for other uses", suggesting that travel time savings which result from proximity to a transit station should be capitalised in the value of property and perhaps in the arrangement of land uses surrounding a station (Boyce *et al.*, 1972).

Assuming that access to destinations reachable by public transit is an important determinant in the value of property, higher property values are expected in places with superior access. Residential property immediately adjacent to a transit station is expected to decrease in value due to congestion effects, while properties radiating out from the station and within walking distance should increase in value.[1]

Previous research investigating the impact of rail transit on property values reveal results of varying magnitude that are sometimes contradictory and most studies are unique to a given locale and do not provide a firm basis to judge future impacts. Furthermore, within the US, much of the research is performed in thriving cities in the Sunbelt area, but such research is just as important in Rustbelt cities experiencing population and economic decline.

This study estimates the impact of proximity to Metro Rail stations in Buffalo's 20-year old light rail system on residential property values. We seek to understand how effects in Buffalo—where population loss has been extreme—differ from effects in cities experiencing population and economic growth. We also explore how effects differ near various station areas, as Metro Rail in Buffalo travels through diverse and uneven neighbourhoods. We test two methods for measuring the distance between a residential property and a light rail station—straight-line distance and network distance—to explore the difference between *actual* distance to a station and *perceived* distance to a station.

Knowledge about the influence that transit proximity has on property values is important, because directing growth and development is of great interest to planners. Rail transit substantially increases property values where transit investments can be co-ordinated with new development in nearby neighbourhoods; on the other hand, where rail transit marginally affects or does not affect property values, transit investments serve primarily to relieve congestion and improve accessibility and mobility but do not contribute to economic growth and urban revitalisation. However, co-ordination between land use, zoning, development and public transport is difficult to achieve, even under the best circumstances.

This study is structured as follows. We review relevant literature and use lessons learned from previous research as a framework for developing a conceptual model of the relationship between property value and proximity to light rail transit that includes explanatory variables. We then operationalise the theoretical model by undertaking hedonic regression models for all Metro Rail stations grouped together as well as each of the 14 stations individually. Finally, we provide concluding observations and recommendations.

Location: Theory and Practice

Proximity to public transit has been proved to offer economic advantages—because of premiums realised by superior access—for most types of real estate (Alonso, 1964; Mills, 1972). A vast body of previous research estimates the impact of proximity to transit stations on land values.

Accessibility is usually measured as the distance from property to transit stations (or sometimes transit corridors) that pedestrians would encounter along the network of streets and sidewalks; a popular research method is to study buffer areas around transit stations using a radial distance of up to one mile around stations, and travel distance—defined as a continuous variable—is commonly used as a proxy for travel time. In some studies, a cruder approximation is used to determine transit proximity; studies that use city-wide property samples often assign a binary variable to indicate whether a house is or is not within one-quarter or half a mile of a transit stop or station (Cervero and Duncan, 2002a).

There are a number of published literature reviews about the effect of proximity to transit on property value (Anas, 1982, 1983; Cervero *et al.*, 2002; Diaz, 1999; Huang, 1994; Knaap, 1998; Parsons Brinckerhoff, 2001; Rice Centre for Urban Mobility Research, 1987; Ryan, 1999; Smith and Gihring, 2004; TCRP, 1998; Vessali, 1996). Observers have noted that inconsistent results and weak evidence of a transport–land-use connection may be due to the complexity of metropolitan development and unpredictable travel patterns (Ryan, 1999). In addition, many studies are context-specific and often fail to produce generalisable results because of unique research methods, unique local transport systems and land use environments.

Researchers have also quantified land use premiums achieved for various modes of public transit, including bus, light rail, heavy rail and commuter rail. There is general agreement amongst most researchers (including Cervero and Duncan, 2002; Lewis-Workman and Brod, 1997) that property near heavy rail accrues greater benefits than property near light rail, owing to the faster speeds, frequent trains and greater geographical coverage of heavy rail. Studies of the effect of proximity to commuter rail have shown that property near commuter rail stations can have higher premiums than light rail or heavy rail, especially when a commuter rail station is at the centre of, or within easy walking distance of, a commercial core or main street (Armstrong, 1994; Cervero, 1984; Cervero and Duncan, 2002a, 2002b; Parsons Brinckerhoff, 2001). Several studies (Barker, 1998; Goodwin and Lewis, 1997; Koutsopoulos, 1977) have shown that property values near bus routes have only modest gains, if any, from transit proximity, because most bus routes lack the permanence of fixed infrastructure. Researchers have also investigated the effect on property values in anticipation of a rail line before construction or service begins (Damm *et al.*, 1980; Dunphy, 1982; Ferguson *et al.*, 1988; Grass, 1992; Grether and Miezkowski, 1974; Knaap *et al.*, 1996; McDonald and Osuji, 1995). However, our current inquiry focuses on studies of light rail and heavy rail, as transit patrons may not distinguish between the two when stations are below ground, as they are in Buffalo's residential neighbourhoods where Metro Rail operates in a tunnel.

We focus on research that explores the link between rail transit and residential property values, ignoring for the moment research on the connection with commercial-office property values (Bollinger and Ihlandfeldt, 1997; Cervero, 1994; Cervero and Duncan, 2002b; Cervero and Landis, 1995; Landis *et al.*, 1995; Hickling Lewis Brod Inc., 2002; Nelson, 1999; Ryan, 2005; TCRP, 1998; Weinberger, 2000, 2001) and retail (Cervero, 1994; Damm *et al.*, 1980; TCRP, 1998) which have generally demonstrated advantages for commercial property to rail proximity. The effects on nearby property values have been well-documented for BART, a heavy-rail system serving San Francisco and Oakland, California, where the effect on property values increased as the rail system's maturation strongly influenced commuting patterns (Cervero and Landis, 1995; Landis *et al.* 1995) and affected, to a lesser degree, land use (Cervero and Landis, 1995).

Keeping in mind that we have carefully narrowed the ample literature to match closely our focus of inquiry, Table 1 summarises previous empirical research on the effect of proximity to light rail and heavy rail transit on residential property values. Numerous studies appearing regularly in scholarly publications since the 1980s provide transport researchers with ample evidence for observing how both light and heavy rail systems affect real estate markets. Some of these studies examine the value of property near transit stations and then make comparisons with similar properties not near transit stations. Other studies develop hedonic estimation models, using residential property values or apartment rent prices as the dependent

Table 1. Effect of proximity to rail transit on residential property values

City–region(s) (transit system) *Authors*	Property value data source	Access measurement	Findings: effect of proximity to rail transit on property value or average home price
Atlanta (MARTA) *Nelson, 1992*	Sales prices (DeKalb County tax assessor)	Straight-line distance to station Measured in 100-ft units from station	Property value increased in low-income neighbourhoods but decreased in high-income neighbourhoods
Atlanta (MARTA) *Bowes and Ihlanfeldt, 2001*	Sales prices (TRW-REDI data services)	Distance rings of one-quarter mile, one-quarter to one-half mile, one-half mile to one mile, one to two miles, and two to three miles from station All property transactions in the city	Property value between one to three miles of stations increased relative to comparable properties located more than three miles. Properties within one-quarter mile decreased by 19 per cent compared with properties beyond three miles
Dallas, Texas (DART) *Weinstein and Clower, 2002*	Assessed values (Dallas County Central Appraisal District)	Straight-line distance to station One-quarter mile from station, compared with properties located in the control group	Property value increased 32 per cent near DART stations compared with 20 per cent in control group areas not served by rail
Miami, Florida (Miami Metro Rail) *Gatzlaff and Smith, 1993*	Sales prices (Dade County property tax records)	Distance to the nearest station One square mile from station	Property value in high-income neighbourhoods slightly higher but unaffected in low-income neighbourhoods Study conducted for eight stations
Queens, New York (New York City MTA) *Lewis-Workman and Brod, 1997*	Sales prices (TRW real estate database)	Network distance to station One mile radius	Property value decreased $2300 for every 100 feet further from station Study conducted for three stations in Queens
Philadelphia, Pennsylvania (SEPTA) *Voith, 1993*	Sales prices (Montgomery County tax assessment file)	Proximity to rail service measured for census tracts.	Property value of single-family homes with access to rail stations is approximately 8 per cent higher than other homes

Portland, Oregon (Eastside MAX) *Dueker and Bianco, 1999*	Sales prices (RLIS database)	Properties in rail corridor compared with properties along a parallel bus corridor, which serves as a control group	Median house value increases at a faster rate closer to stations. A house located at a station will decrease by 5 per cent, 2 per cent and 1 per cent, if located at 400 feet, 600 feet and 800 feet further from station, respectively
Portland, Oregon (Eastside MAX) *Chen* et al.*, 1998*	Sales prices (RLIS Lite and Metroscan)	Straight-line distance to station One km radius	Property value decreased $32.20 per metre further from station beginning at a distance of 100 metres from station
Portland, Oregon(Eastside MAX)*Lewis-Workman and Brod, 1997*	Assessed values (city property tax rolls)	Network distance to station One mile radius	Property value increased $76 for every 100 feet closer (within a one-half to one mile radius) to three stations that were studied
Portland, Oregon (Eastside MAX) *Al-Mosaind* et al.*, 1993*	Sales prices	Distance rings based on walking One km radius (Model 1)Network distance to station One-half km radius (Model 2)	Property values were $4.32 higher within the 500 metres than outside the 500 metre radius (Model 1). Property value decreased $2175 for every 100 metres further from station (Model 2) Study conducted at seven suburban stations.
Sacramento, California (Sacramento Light Rail) *Landis* et al.*, 1995*	Sales prices (TRW-REDI data services)	Network distance to station All property transactions in the city	No statistically significant effect on home prices
San Diego, California (San Diego Trolley) *Landis* et al.*, 1995*	Sales prices (TRW-REDI data services)	Network distance to station All property transactions in the city	Property value increased $272 for every 100 metres closer to station
San Diego, California (San Diego Trolley) *Cervero and Duncan, 2002a*	Sales prices (Metroscan)	Distance rings of one-quarter and one-half mile from station	Property value increased 10 per cent (East Line) to 17 per cent (South Line) for multi-family homes

(*Table continued*)

Table 1. Continued

City–region(s) (transit system) *Authors*	Property value data source	Access measurement	Findings: effect of proximity to rail transit on property value or average home price
San Francisco (BART) *Lewis-Workman and Brod, 1997*	Sales prices	Network distance to station One mile radius	Property value decreased $1578 for every 100 feet further from station Study conducted for one station (Pleasant Hill)
San Francisco, California (BART) *Landis* et al.*, 1995*	Sales prices (TRW-REDI data services)	Network distance to station All property transactions in the two counties	Property value (1990) for single-family homes decline by $1.00 to $2.00 for every metre further from BART station
San Jose, California (San Jose Light Rail) *Landis* et al., *1995*	Sales prices (TRW-REDI data services)	Network distance to station All property transactions in the city	Property value decreased $197 for every 100 metres closer to station Effect may be due to commercial and industrial uses
San Jose (Santa Clara VTA) *Cervero and Duncan, 2002a*	Sales prices (Metroscan)	Straight-line distance to station One-quarter to one-half mile from station	Property value of apartments and homes increased 1–4 per cent, but decreased 6 per cent for condominiums
St Louis, Missouri (MetroLink) *Garrett, 2004*	Sales prices (First American Real Estate Solutions)	Straight-line distance to station One mile buffer around the light rail route and stations	Property value increased 32 per cent or $140 for every 10 feet closer to station, beginning at 1460 feet
Washington, DC (Metro) *Benjamin and Sirmins, 1996*	Apartment rents (various property management and apartment locator services)	Distance to station is measured in tenths of miles from station All properties in the city	Apartment rent decreased 2.5 per cent for every one-tenth mile further from station There were a total of 250 observations from 81 apartment complexes

variable, to estimate premiums on property in rail station areas. Most of the studies use statistical controls when investigating property values and the explanatory variables usually include characteristics of properties and the neighbourhood quality in which properties are located. Some studies consider suburban stations, but most consider stations in urban neighbourhoods, as all rail networks serve a central business district. The studies—which vary in their degrees of sophistication—investigate property values in a wide range of metropolitan settings, including downtowns, urban neighbourhoods, mature suburbs, new suburbs and exurbs.

In general, the studies do indeed find a statistically significant and positive correlation between access to rail stations and residential property values—although magnitudes vary—and the greatest effects are found within areas nearest the transit stations, although being *too close* to a station can sometimes result in a price decrease. Findings of these studies indicate that property in transit station areas experienced up to a 32 per cent premium (Garrett, 2004) (see also Debrezion *et al.*, 2006). However, a few studies found no significant effect on property values (Gatzlaff and Smith, 1993) and studies in San Diego and San Jose found a decrease in property values, which may be explained by the industrial character of certain neighbourhoods (Ihlanfeldt and Boehm, 1987) served by light rail aligned along freight corridors. Property values increased in low-income neighbourhoods in Atlanta and increased in high-income neighbourhoods in Miami, reinforcing the observation that the studies are highly context-specific, with effects on land values sometimes realised unevenly throughout transit systems and unevenly across various neighbourhood types. In some cases, negative premiums on property values are observed and attributed to nuisance effects, including noise, safety, aesthetics and traffic (Al-Mosaind *et al.*, 1993; Landis *et al.*, 1995). While nuisance effects may reduce property prices in immediate station areas, the net positive effect on land values from a regional perspective is often considered to outweigh localised devaluations.

Research Plan

Context

Much of the research about this topic has been conducted in growing metropolitan regions in high-growth states such as California and Texas (see Table 1). Our current investigation, however, fills a gap in this research by examining Buffalo, a slow-growth city that has experienced steep economic decline and staggering population loss in the past several decades.

Research about the impact of rail transit on adjoining property values is important in a Rustbelt metropolitan area with decreasing and sprawling population (Fairbanks, 2004) as it helps to shed light on the promise of public transit for revitalising cities and the potential for planning future rail transit investments. We intend the findings from this research to be useful to urban planners and transit officials in Buffalo at a time when they are considering various methods to increase transit ridership, including station area development (NFTA, 2004) and to planners and policy-makers anywhere who seek knowledge about the complexities of the interrelationship between housing markets and public transit accessibility.

Perhaps no metropolitan region with a relatively 'new' light rail system has experienced urban decline to the degree that Buffalo has. We consider the 20-year population growth or decline—for the period between 1980 and 2000—for the cities and metropolitan regions in Table 1 with new light rail systems. Most of these light rail systems, and subsequent extensions, were constructed in the 1980s and 1990s. Figure 1 shows that the population loss of 18 per cent in the City of Buffalo and 6 per cent in its metropolitan area over the 20-year period is unparallelled. Only one other central city—St Louis—lost population, but that was offset to some degree by population growth in the metropolitan area. All of the central cities increased population by 30 per cent or more and all of the metropolitan areas (except for St Louis) increased in population by 30 per cent or more. Population loss in the Buffalo

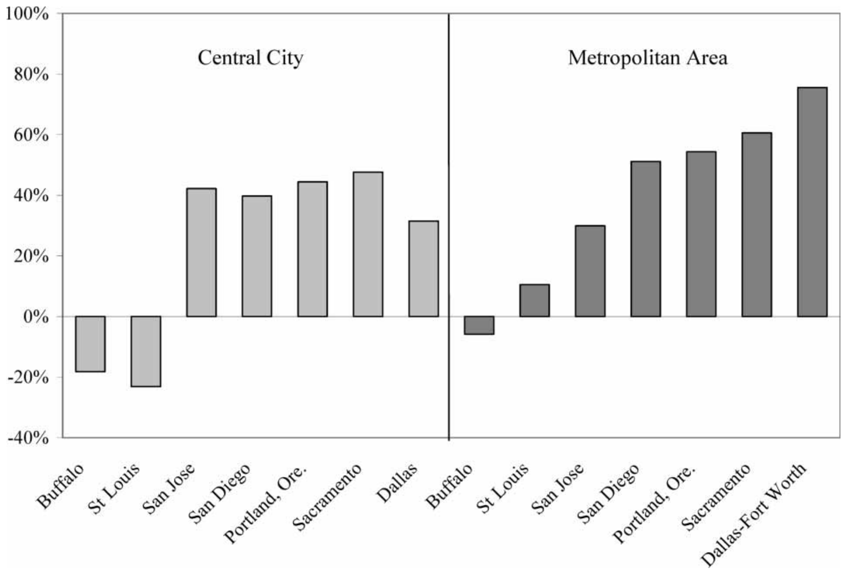

Figure 1. Population change, 1980–2000. *Source*: US Census, 1980, 2000.

metropolitan area has certainly been tremendous, especially in the central city, and this provides a unique opportunity for studying the influence of light rail proximity on property values.

Hypothesis

Previous research shows that accessibility benefits accrue for properties—in a variety of contexts and settings—by proximity to a rail station and that these benefits capitalise in land value. We therefore assume that, as the distance to a light rail station decreases, accessibility benefits accrued by homeowners or occupants will be greater, resulting in a higher price of property value. Our null hypothesis is that as the distance to the rail station increases, there is no impact on property values, implying that proximity to Buffalo's light rail accrues insignificant accessibility benefits for nearby properties. Taking into account economic decline and population loss in Buffalo, however, we expect the light rail transit effect on nearby property values to be less than it might be in other places. Metro Rail has served Buffalo for more than 20 years, so we assume that adjustments in people's travel behaviour to rail service and transformation to land use near rail stations are stabilised. While effects from transport improvements are generally expected to develop over a long period of time (Giuliano, 2004), we assume that the residential property value response to light rail proximity has by now reached equilibrium.

Methodology

Study Area

A rapid transit system was first proposed for Buffalo in the late 1960s to connect downtown Buffalo with various suburban locations like the Greater Buffalo International Airport, the new State University of New York suburban campus in Amherst, downtown Niagara Falls and southern suburbs. One of the key objectives of the new transit plan was to anchor the revitalisation of the central business district and arrest population decline (Berechman and Paaswell, 1983; Gargan, 1984; Wallace McHarg Roberts & Todd, 1971). In 1969, the state's Office of Planning Co-ordination concluded that the Buffalo–Amherst Transit Corridor between downtown Buffalo and the newly proposed State University at Buffalo in Amherst had the greatest potential returns among other alternative routes and alignments (New York State Office of Planning Co-ordination, 1969). Urban density along the corridor was believed to be sufficient to support heavy rail service, although planners subsequently downgraded the system to light rail in the 1970s because of high cost projections and lower ridership expectations.

Buffalo's light rail system began service in 1985 and cost $1.3 billion (2005 dollars). It follows the alignment of Main Street, a commercial spine, from the Inner Harbor in downtown Buffalo to the State University at Buffalo south campus. Metro Rail enhances accessibility by providing additional commuter capacity, but it did not provide transit access in new places when it was built, as the route serves downtown and established neighbourhoods that already had bus service (Banister and Berechman, 2000).

The light rail line departs from its original conception (New York State Office of Planning Co-ordination, 1969) by offering no service in the suburbs; as a consequence, the 6.4-mile route operates at-grade downtown and below-grade *en route* to the city's northeastern boundary. The location and route suggest that planners hoped to revitalise downtown and urban neighbourhoods with Metro Rail rather than locating Metro Rail in the path of new development, most of which was occurring in the suburbs.[2] Figure 2 shows that the light rail system was conceptualised, planned, constructed and began service when the City of Buffalo and its suburbs were in a period of serious decline—characterised by out-migration of population and intraregional suburbanisation (Banister and Berechman, 2000)—that unarguably dampened housing demand.[3]

Like many Northeastern and Rustbelt cities, Buffalo has experienced abandonment and economic decline—especially a loss of blue-collar employment—since the 1950s as its manufacturing and industrial base became obsolete. Population declined by 50 per cent between 1950 and 2000, and 2000 marked the first time since 1890 that the city's population fell below 300 000 people. Demographic data reveal that the median annual household income is $24 500 and that 21 per cent of working-age adults are in poverty (Hess, 2005; US Census 2000, Summary Files 1 and 3). Like other Rustbelt cities,

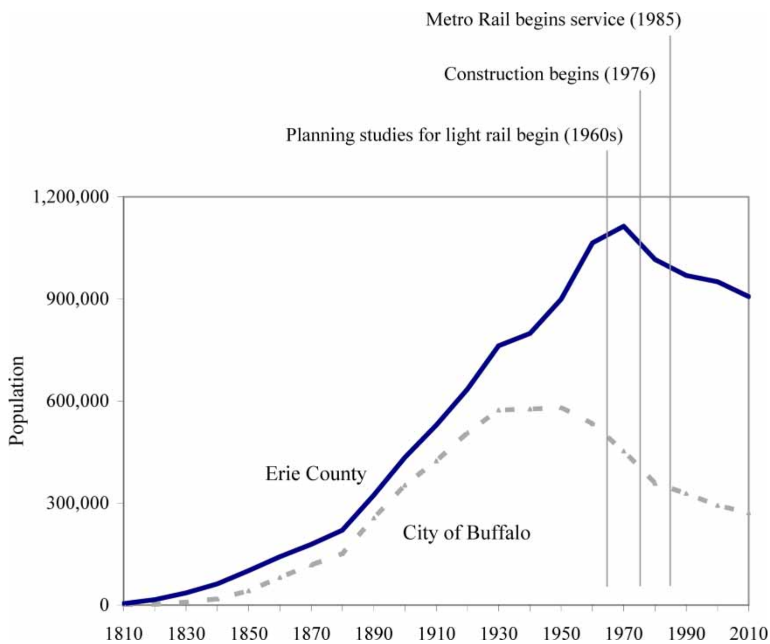

Figure 2. Population of City of Buffalo and Erie County, 1810–2010. *Sources*: see note 3.

Buffalo experiences racial segregation, poverty, low incomes and low automobile ownership, and limited access and mobility for many segments of the population (Buckham, 2004; Hess, 2005). The region also has seen sluggish job growth, loss of high-income jobs, population decline in the important 20- to 34-year-old age-group and high out-migration (Fiscal Policy Institute, 2003; Pendall, 2003). The Buffalo metropolitan area lags behind the US in both earnings and investment (Pendall and Christopherson, 2004) and high local and county taxes and persistent tax increases have hurt the competitiveness of the region in attracting businesses and residents (Duncombe, 2002). The patterns have become entrenched and now negatively affect property values citywide (Potepan, 1996), which are further depressed by an expectation of little growth (Capozza and Helsley, 1989).[4] In recent years, homeowners, not commercial businesses, have shouldered most of the burden of the increase in property tax revenue. Beginning in 2001–02, residential property values jumped 22 per cent in 4 years, while commercial assessments increased only 2 per cent (Cervantes and Dolan, 2005).

Despite a presumed high degree of transit dependency—31 per cent of households do not have a vehicle available (Census 2000)—ridership on Metro Rail has declined steadily (Lakamp, 1999) and has consistently underperformed expectations (Kain, 1988; Pickrell, 1992; Richmond, 2005; UMTA, 1989).[5] Figure 3 shows that average weekday boardings for 2002 and 2003, the most recent years for which data are available, are below 20 000, which is lower than the number of boardings in 1986, the first full year of operation.

Figure 4 shows the 6.4-mile Metro Rail route and 14 stations. The six southerly stations are located downtown in a free-fare zone along an automobile-free pedestrian mall, through which Metro Rail operates at grade. Although hundreds of residential units

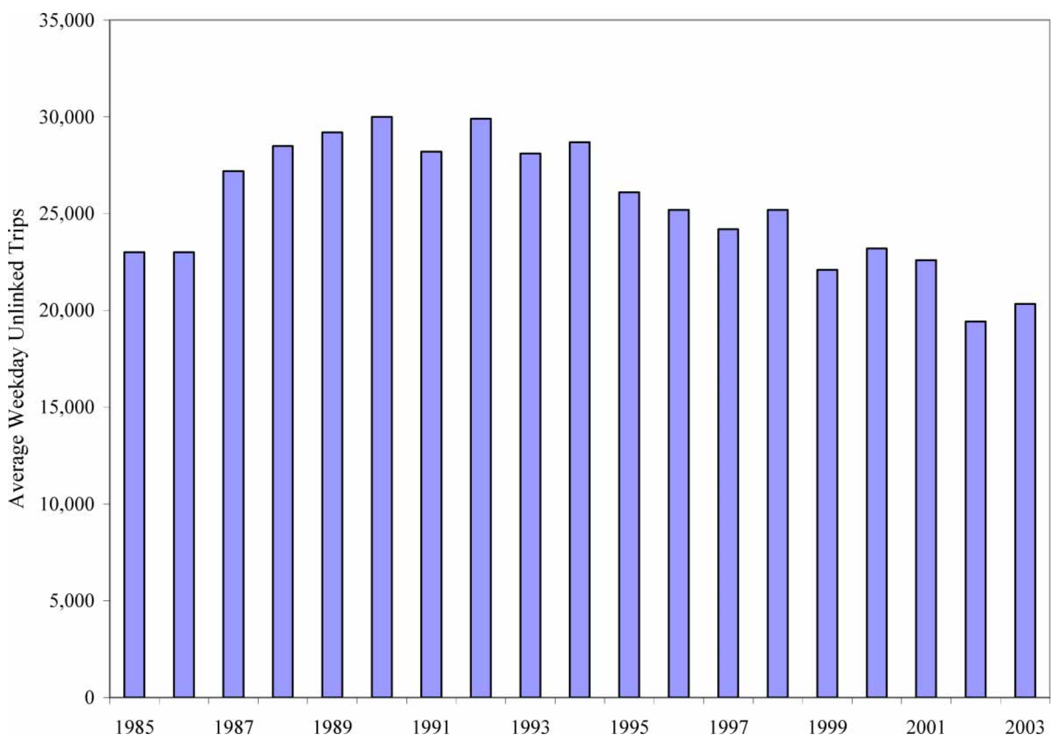

Figure 3. Average weekday unlinked trips on Metro Rail, 1985–2003. *Source*: NFTA (2005).

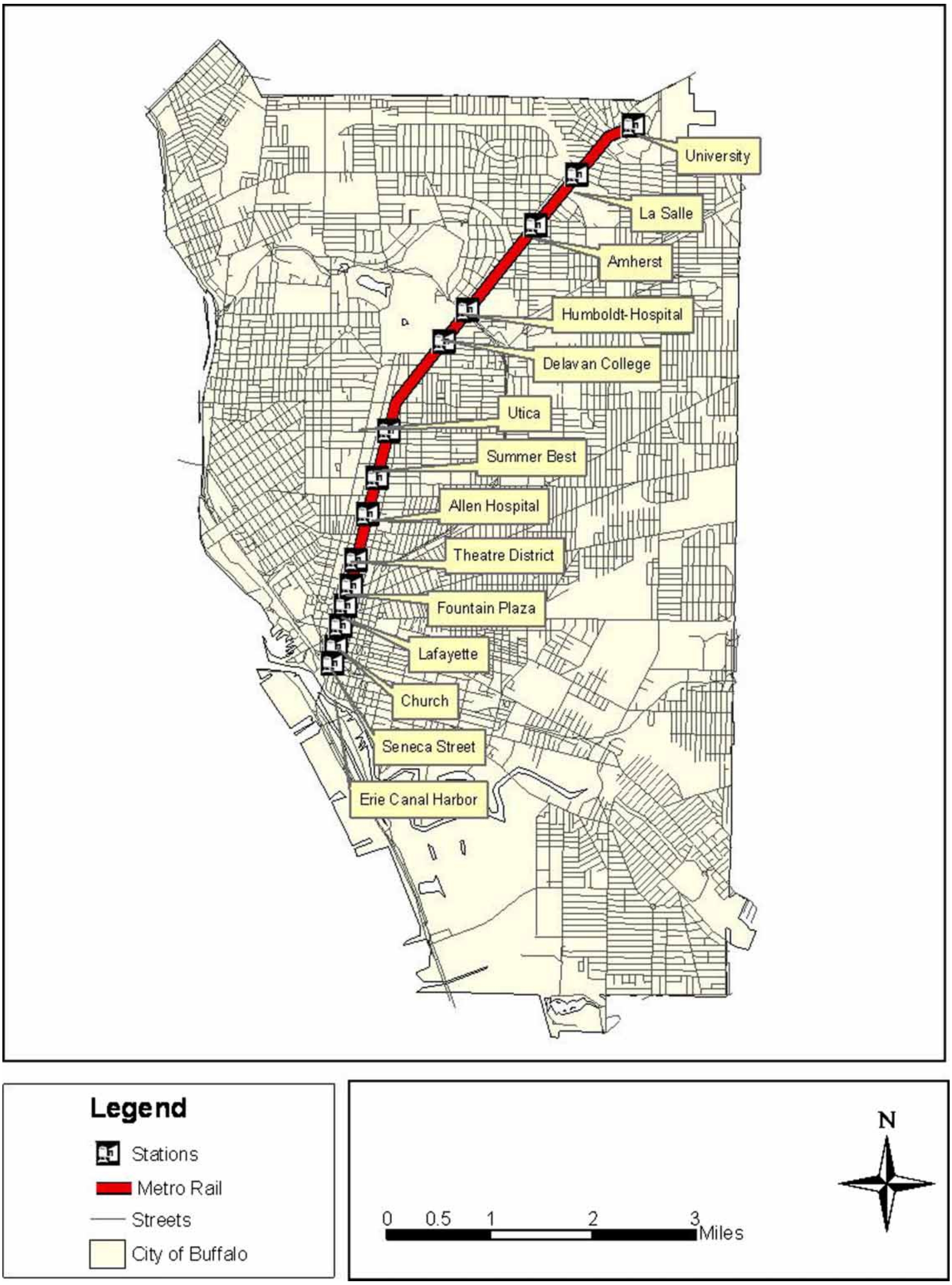

Figure 4. Study area.

are planned or under construction, Buffalo's downtown residential population is small and has not expanded in recent years as downtown neighbourhoods have in other rustbelt cities such as Cleveland and Pittsburgh. Metro Rail descends into a tunnel to serve the eight northerly stations, which are located underground. Pedestrian access around stations is generally good, with mature street networks and sidewalks, although station amenities—especially retail and commuter services—are lacking (Hess and Lombardi, 2004). Metro Rail riders can make direct transfers to bus routes at all eight of the below-ground stations and can easily transfer to bus routes from the six at-grade stations; from Metro Rail stations, riders can transfer to 46 of the system's 55 bus routes. Free parking is provided at park-and-ride lots at the two stations furthest from the central business district, LaSalle and University; no other Metro Rail stations possess adjacent parking lots.

Data Sources

While many previous studies have used real estate transaction databases, we instead use the 2002 assessed value of properties from the assessor's database for the City of Buffalo, the most comprehensive and reliable government data source for residential property values. Our sample thus includes the universe of residential properties in our study area, while real estate transactions would only have included properties that changed hands. In Buffalo, residential properties are assessed based upon 100 per cent of market value. This assessor's database contains descriptive variables such as the number of bedrooms, the number of bathrooms and the year the structure was built. The benefit of this database, compared with other relevant real estate databases such as sales transactions, is the absence of significant bias. We consider further only residential parcels for which all attributes are available.

To include the effect of other variables such as incidence of crime and types of crime, 2002 data were collected from the Erie County Central Police Service and the Buffalo Police Department. Occupancy rate change and population growth rate change from 1990 to 2000 were computed using demographic data collected from the 1990 and 2000 US Census.

GIS was used to measure continuous geographical distances such as distances from the parcels to the nearest station, to the nearest park, to Delaware Park and to the central business district. GIS was also used to determine whether a parcel is located on the east side or west side of the light rail corridor.

Planners typically assume that people will comfortably walk approximately one-quarter of a mile to reach transit stops or stations (Untermann, 1984). We expand the pedestrian access distance to a half mile radius around stations, in order to capture the variation in property values not necessarily observed within the one-quarter mile radius. However, the nearness of station spacing in Buffalo means that half-mile buffer areas around stations sometimes overlap, as shown in Figure 5. The average distance between adjacent stations is approximately half a mile.[6] GIS is used to draw continuous straight-line distances from each parcel to the nearest station, thereby assigning each parcel to the nearest station. That is, each parcel is assigned to the nearest station; if a parcel is within half a mile of two stations, it is used in the model only for its assigned station.

Property Value Estimation

The price of property is influenced by a number of factors, including population growth, economic conditions, quality of life and nearby amenities (Brigham, 1965; Cervero *et al.*, 2002; Landis *et al.*, 1995; Quigley, 1985). In Buffalo, property prices are affected by factors relevant to the declining economy such as population loss, crime in neighbourhoods, low incomes and high vacancy rates. To specify an appropriate model, we first plot on a scattergram the values of the dependent variable (assessed property value) as a function of the independent variable (distance from property to nearest station). As the distance from a rail station increases, the assessed property value changes proportionally by either increasing or decreasing. The linear relationship revealed in the scattergram is not surprising, considering Buffalo's relatively flat housing market, where within the Metro Rail corridor there are no pockets of high housing demand associated with economic activity that one might

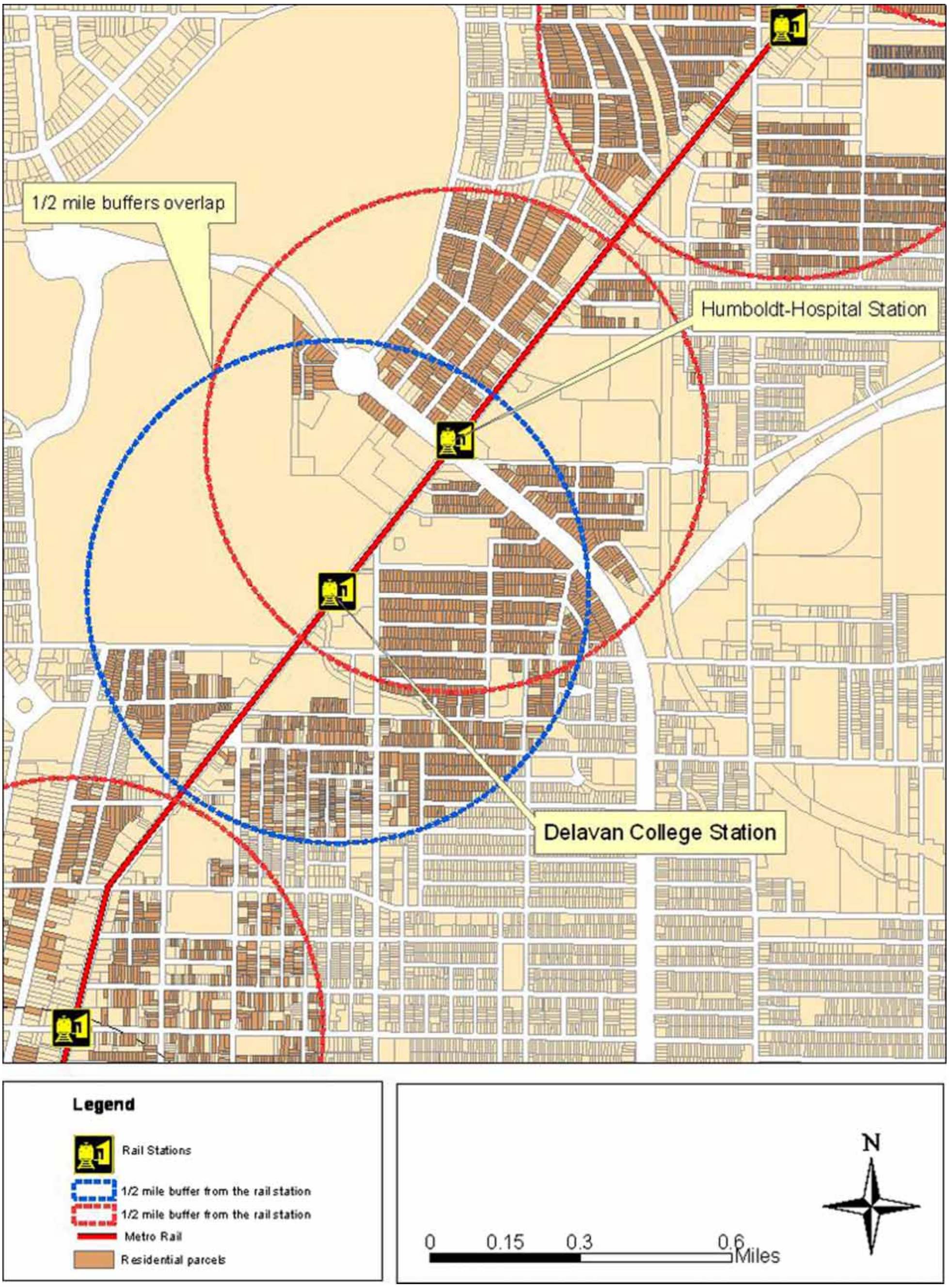

Figure 5. Half-mile radius buffer areas surrounding metro rail stations.

expect to find in a high-growth region. We choose hedonic regression analysis[7] for hypothesis testing, since this method isolates the factors that might affect property values and estimates the influence on property value attributed to proximity to light rail stations (Rosen, 1974; Can, 1990).[8] The conceptual hedonic regression model is

$$P = f(\boldsymbol{Pr}, \boldsymbol{H}, \boldsymbol{L}, \boldsymbol{N}) \tag{1}$$

where, the dependent variable *P* is the assessed property value in dollars, which is a function of four vectors of independent variables. The four integrated vectors are: **Pr**, a vector of variables that measure the proximity of properties to light rail stations; **H**, a vector of variables that describe housing characteristics; **L**, a vector of variables that describe locational amenities; and **N**, a vector of variables that describe neighbourhood characteristics.

In this way, we estimate the importance of housing characteristics, locational amenities and neighbourhood characteristics in defining the relationship between residential property value and light rail station proximity. Table 2 provides a list of the 18 independent variables in the 4 vectors, along with the definition, unit of measurement and data source for each variable. The property value, *P*, is reported for each of the 7357 residential parcels in 2002 dollars. Properties are assessed at 2002 market values.[9]

The four vectors of independent variables that influence property values are described in greater detail below.

(1) *Rail Proximity* (**Pr**) measures distances (in feet) from each residential parcel to the nearest rail station.[10] The variable is measured using two methodologies (Clifton and Handy, 2001). In the straight-line distance model, the distance (*STR_DIST*) in feet is measured along the shortest possible straight line—sometimes called crow-flight distance—drawn using GIS and connecting each residential parcel to the nearest rail station. In the network distance model, the distance (*WALK_DIST*) in feet is measured along the street network, simulating the actual pedestrian route of travel that a commuter would walk between home and the rail station.[11] The network distance between a property and the nearest station may be the same as the straight-line distance, but it can never be shorter. These two methods are shown side-by-side in Figure 6 for four station areas. The distances drawn between all parcels to the nearest rail station are shown as straight-line distances on the left-hand side and as street network distances on the right-hand side.

(2) *Property characteristics* (**H**) are attributes unique to a parcel and the residential structure on the parcel (Kain and Quigley, 1970b; Follain and Jimenez, 1985). They include lot area (*AREA*), age of house (*AGE*), number of bedrooms (*BEDRMS*), number of bathrooms (*BATHRMS*) and number of fireplaces (*FIRE*). Dichotomous variables indicating single- as opposed to multi-family housing (*SINGLE*) and the presence of a basement (*BASEMT*) are included.[12] Parcels that do not contain all of these attributes (approximately 2 per cent) are eliminated from the study.

(3) *Accessibility and location* (**AL**) includes variables that describe city-wide access, proximity to amenities (Fausold and Lilieholm, 1999; Schroeder, 1982) and proximity to the central business district based on a standard model of urban land use (Alonso, 1964; Brigham, 1965; Muth, 1969). In this study, Niagara Square was assumed as the focal point of the central business district (CBD) which controls property values. This variable was calculated by measuring the straight-line distance from Niagara Square in downtown Buffalo to the centroid of each residential parcel. Other variables include proximity (measured by straight-line distance) to the nearest park (*NPRK*), proximity to Delaware Park (*DELPRK*)—the largest park in the city and surrounded by cultural attractions—and a dummy variable (*EAST*) to indicate whether parcels are located on the east side or the west side of Buffalo. Main Street acts as an historical segregating divider between the city's dilapidated East Side, where there are high shares of Blacks/African Americans and low-income families, from the West Side, where there are more Whites and middle- and high-income families.[13]

Table 2. Definition of variables and data sources

Vector	Variable	Operational definition	Units	Data source
Dependent variable				
Assessed property value (*PRICE*)	*PRICE*	Assessed value (per square foot) of land plus improvements	$ (2002)	City assessor
Independent variables				
Rail station proximity (Pr)	*STR_DIST*	Straight-line distance	Feet	Calculated using GIS
	WALK_DIST	Walking distance along street network	Feet	Calculated using GIS network analyst
Property characteristics(H)	*AREA*	Area of parcel	Square feet	City assessor
	AGE	Age of structure	Years	City assessor
	BEDS	Number of bedrooms	Number	City assessor
	BATHRMS	Number of bathrooms	Number	City assessor
	SINGLE	Single-family housing	Dichotomous variable (0 or 1)	City assessor and NY State ORPS
	FIRE	Number of fireplaces	Number	City assessor
	BASEMT	Presence of basement	Dichotomous variable (0 or 1)	City assessor
Locational amenities (L)	*CBD*	Straight-line distance to CBD	Feet	Calculated using GIS
	NPARK	Straight-line distance to the nearest park	Feet	Calculated using GIS
	DELPRK	Straight-line distance to Delaware Park	Feet	Calculated using GIS
	EAST	East side dummy variable	Dichotomous variable (0 or 1)	Calculated using GIS
Neighbourhood characteristics (N)	*PROPCMR*	Property crime rate	Crimes per capita (for block group)	Buffalo Police Dept (ECCPS) 2002 and US Census 2000
	VCMR	Violent crime rate	Crimes per capita (for block group)	Buffalo Police Dept (ECCPS) 2002 and US Census 2000
	MEDINC1999	Median income	$ (1999) (for block group)	US Census 1990, 2000
	OCCRTE	Occupancy rate change	Fraction per decade	US Census 1990, 2000
	POPRTE	Population growth rate	Fraction per decade	US Census 1990, 2000

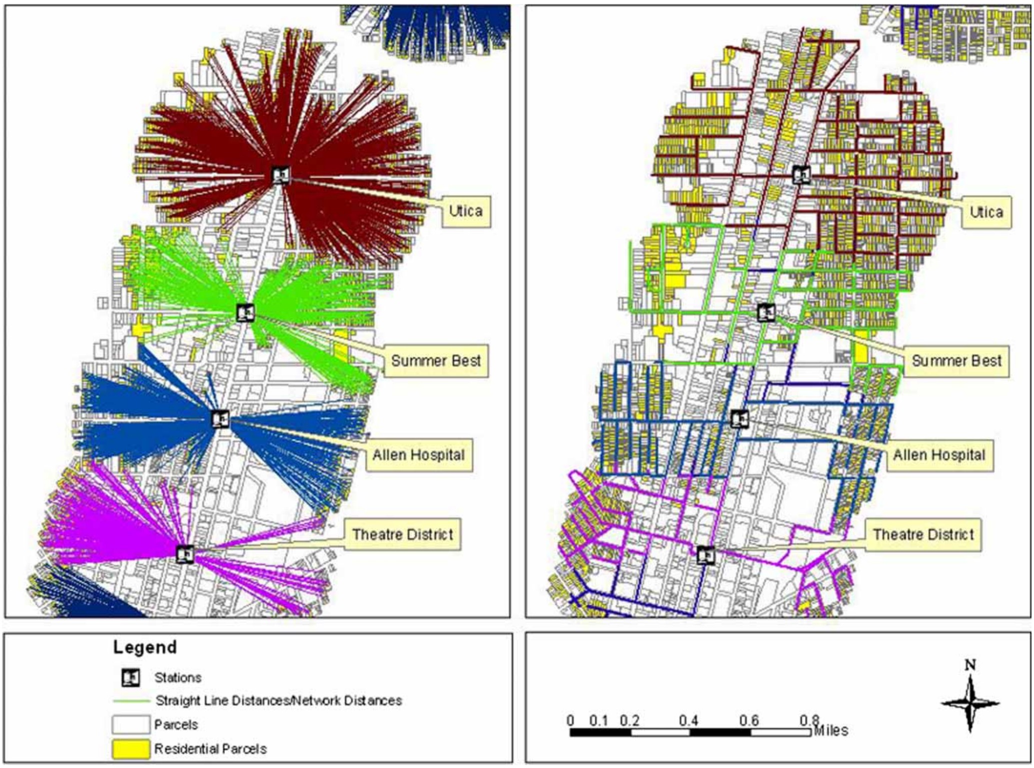

Figure 6. Straight-line distance and network distance.

(4) *Neighbourhood characteristics* (**N**) contains attributes unique to a group of contiguous properties that may affect property values (Bowes and Ihlandfeldt, 2001; Ding *et al.*, 2000; Malpezzi, 1996; Muth and Goodman, 1989). The vector includes median household income (*MEDINC1999*) (Yinger, 1979) and two measures of neighbourhood crime (Manning, 1988)—property crime rate (*PROPCMR*) and violent crime rate (*VCMR*). The crime rates are calculated by dividing the number of crimes that occurred in a census tract by the population of that census tract. Other neighbourhood characteristics include occupancy rate change (*OCCRTE*)—the change in housing occupancy rate between 1990 and 2000—and population growth rate change (*POPRTE*)—the population growth rate between 1990 and 2000 (US Census 1990 and 2000, Summary Files 2 and 3). The latter two variables are designed to capture changes in housing demand.[14]

Analysis

The cross-sectional assessment database includes 7357 residential parcels—both single-family and multi-family houses—located within a half mile radius of each of the rail stations.[15] We enrich the parcel dataset by combining it with GIS to allow measurement of distances between properties and rail stations.

Previous research (see Table 1) suggests that there are two methods for measuring the distance from a property to a transit station. The first method uses the straight-line distance from a property to the nearest rail station and thus measures *perceived* distance. That is, a property owner may perceive a transit station to be within a certain distance of the property, even though natural or man-made barriers may prevent a pedestrian from travelling along the shortest straight-line route to reach the transit station. The second method uses a route along the street network from a property to the nearest rail station and measures *actual* walking distance. We assume that pedestrians only walk where there are streets, sidewalks, pathways or pedestrian bridges. We choose to measure proximity to rail using two methods to investigate whether *perceived distance* or *actual walking distance* to transit is more important in influencing price variations.

An individual regression equation is developed for each of the 14 stations and one regression model is developed that encompasses *all* of the stations.[16] We calculate Pearson's correlation coefficient '*r*' and use the results to eliminate multicollinearity among independent variables. Pairs of independent variables that produce a correlation coefficient of 0.6 or higher are eliminated from the particular regression model wherein a correlation occurs. Table 3 provides descriptive statistics for the dependent variables, including the mean, maximum, minimum and standard deviation.

Findings

All Stations Model

We first report the results of the all stations model—a summation of the relationships observed at *all* of the stations along the light rail—in Table 4. The model fits the data well and explains 71 per cent of the variation in residential property price. The various attributes that influence property values are significant at the 0.10 level and have the expected positive or negative signs.

The model results suggest that, system-wide, property located within a half-mile radius of rail stations is valued \$2.31 higher (using geographical straight-line distance) and \$0.99 higher (using network distance) for every foot closer to a light rail station. Consequently, an average home anywhere in the study area along the light rail line would generally be worth between \$990 and \$2310 more than the average home if it were within 1000 feet of a station. The following interpretations of estimated coefficients are

Table 3. Characteristics of variables

Vector	Variable	Mean	Standard deviation	Minimum	Maximum
Dependent variable					
Assessed Property Value (PRICE)	PRICE	70 380.49	52 901.88	1 000.00	1 100 000.00
Independent variables					
Rail proximity (**Pr**)	*STR_DIST*	1 803.34	536.08	129.78	2 610.95
	WALK_DIST	2 502.48	803.03	46.03	4936.15
Property characteristics (**H**)	*AREA*	4 804.90	3 083.25	297.00	142 345.00
	AGE	87.81	22.28	6	203
	BEDS	4.39	1.37	0	10
	BATHRMS	1.87	0.68	1	7
	SINGLE [a]	0.55	0.50	0	1
	FIRE	0.30	0.57	0	7
	BASEMT [a]	0.96	0.19	0	1
Locational amenities (**L**)	*CBD*	17 458.48	7 853.10	1 361.05	30 183.52
	NPARK	4 187.41	1 820.60	369.36	8 224.25
	DELPRK	8 777.26	3 358.01	1 895.69	22 816.25
	EAST [a]	0.53	0.50	0	1
Neighbourhood quality (**N**)	*PROPCMR*	0.04	0.02	0.00	0.56
	VCMR	0.02	0.02	0.00	0.51
	MEDINC1999	31 299.28	20 117.74	0	146 379.00
	OCCRTE	−0.03	0.21	−1.00	1.68
	POPRTE	−0.06	0.21	−1.00	1.62

Notes: [a]Dichotomous variables. All other independent variables are continuous.

Table 4. Estimated model for all stations

Vector	Independent variable	Straight-line distance: Parameter estimate	Straight-line distance: Probability	Network distance: Parameter estimate	Network distance: Probability
Rail proximity (**Pr**)	*STR_DIST*	−2.31	−3.50**		
	WALK_DIST			−0.99	−2.22*
Property characteristics (**H**)	*AREA*	4.09	32.84**	4.09	32.77**
	AGE	−33.97	−2.02*	−32.31	−1.92*
	BEDS	NA	NA	NA	NA
	BATHRMS	25054.33	39.10**	25085.11	39.13**
	SINGLE	15399.70	19.06**	15485.18	19.14**
	FIRE	16178.64	23.20**	16230.09	23.26**
	BASEMT	7445.44	4.06**	7561.51	4.12**
Locational amenities (**L**)	*CBD*	0.36	6.99**	0.38	7.41**
	NPARK	NA	NA	NA	NA
	DELPRK	0.32	2.91**	0.29	2.67**
	EAST	−28516.69	−36.21**	−28418.35	−36.09**
Neighbourhood quality (**N**)	*PROPCMR*	NA	NA	NA	NA
	VCMR	−291.67	−14.94**	−287.03	−14.72**
	MEDINC1999	0.36	17.02**	0.36	16.95**
	OCCRTE	NA	NA	NA	NA
	POPRTE	13436.83	7.21**	13943.13	7.46**
Model statistics		$n = 7357$; df = 13; adjusted $r^2 = 0.71$; $p = 0.05$		$n = 7357$; df = 13; adjusted $r^2 = 0.71$; $p = 0.05$	

Notes: *p < 0.10, significant at the 0.10 level; **p < 0.05, significant at the 0.05 level; ***p < 0.01, significant at the 0.01 level. Variables marked NA are eliminated due to multicollinearity.

drawn from the vectors of independent variables

—Among property characteristics, *AREA* and *BATHRMS* are the most statistically significant independent variables and both positively influence property value. For every square foot increase in the lot area, the property value increases by about $4 (for both straight-line and network distance model). For each additional bathroom, the property value increases by about $25 000 (for both straight-line and network distance model).

—Among locational characteristics, the *EAST* dummy variable is the most statistically significant. The model suggests that if a property is located on the East Side—which has the city's largest share of African Americans and low-income households—property values are likely to decrease by about $28 000 (in both straight-line and network distance model). The distance to the CBD is the second most statistically significant independent variable. For every foot closer to the CBD, there is a small decrease in property value at the rate of $0.36 per foot, indicating consistently higher property values in neighbourhoods further from downtown.

—Among variables describing neighbourhood quality, median income level (*MEDINC2000*) followed by violent crime rate (*VCMR*) are the most statistically significant. Median income has only a marginal positive impact on property values: every $100 increase in the median annual household income is associated with a $36 increase in property value, suggesting that houses are more likely to sell for a higher price in affluent neighbourhoods. Higher violent crime rate has a negative impact on property value: every 1 per cent increase in violent crime rate is associated with a decrease in property value of about $292 (straight-line distance model) and about $287 (network distance model).

The independent variables possess various units of measurement, making it difficult to compare the relative impact of each independent variable on the dependent variable. To overcome this, we calculate the standardised partial regression coefficient, $\beta_{standardised}$, for each independent variable using the following formula

$$B_{standardised} = [\beta_i{}^*(\text{std}\, x_i)]/(\text{std}\, y) \tag{2}$$

where, β_i is the slope coefficient of an independent variable; std x_i is the standard deviation of an independent variable; and std y is the standard deviation of the dependent variable.

Thus, the partial regression coefficients are converted to β-values in the all stations model using the following empirical relationship

$$\begin{aligned} PRICE = \beta_0 &- 0.02(STR\_DIST) \\ &+ 0.24(AREA) \\ &- 0.01(AGE) + 0.32 \\ &(BATHRMS) + 0.15(SINGLE) \\ &+ 0.17(FIRE) + 0.03(BASEMT) \\ &+ 0.05(CBD) + 0.02(DELPARK) \\ &- 0.27(EAST) - 0.11(VCMR) \\ &+ 0.14(MEDINC1999) \\ &+ 0.05(POPRTE) \end{aligned} \tag{3}$$

When we standardise the unit of measurement for the independent variables to make them comparable, three variables—number of bathrooms (*BATHRMS*), size of the parcel (*AREA*) and location on the East Side of Buffalo (*EAST*)—are *more* influential than rail proximity in predicting property values. The β-value for number of bathrooms is about 14 times greater and the β-value for proximity of the parcel on the East Side is about 12 times greater than the β-value for rail proximity (in both straight-line distance and network distance model). Parcels located on the East Side of Buffalo have a negative effect on property values, whereas larger lot sizes and number of bathrooms have a positive impact on property values.

Individual Station Models

The all stations model provides an analysis of the cumulative effects of rail proximity on adjoining station area properties for the entire light rail system. The results indicate a marginally positive impact on property values. However, individual regression models for each of the 14 stations indicate that the effects are not felt evenly throughout the system (Almeida, 2004). Summary results are presented in Table 5.

Table 5 also lists the median household income near each station which suggests the relative affluence of station-area neighbourhoods. The premiums homeowners will pay for station proximity is greater in high- than in low-income neighbourhoods, despite the assumption that many low-income residents who cannot afford automobiles would pay a premium on housing to live near a light rail station. Near some stations, the effects of light rail proximity may be dampened by overall neighbourhood effects on property values (Knaap, 1998).

Proximity to University station, Amherst station, Delavan-Canisius College station and Allen-Medical Campus station has statistically significant positive effects on property values in both models and proximity to Utica station, Summer-Best station and Theater station has statistically significant negative effects on property values in both models. LaSalle station shows statistically significant results in only the straight-line distance model and Fountain Plaza shows statistically significant results in only the network model. Two stations—Lafayette Square and Humboldt-Hospital—fail to show statistically significant effects in either model; at these two stations, there is insufficient evidence to conclude that a statistically significant relationship exists between property value and accessibility to rail transit.

Interestingly, the second-highest positive price effects on property values are felt at University station—the furthest station from the central business district—which does not provide support for the contention that the amount of commuting time saved is

Table 5. Estimated model for individual stations

Station	N (number of residential properties within half a mile)	Median household income $ (1999)	Change in property value (in dollars) per foot closer to station: Straight-line distance	Network distance
University	697	33 828	+6.72**	+4.39**
LaSalle	1175	22 578	+3.01**	+0.80
Amherst Street	1510	35 417	+6.25**	+3.65**
Humboldt-Hospital	830	35 667	+2.22	−3.09
Delavan-Canisius College	1020	23 125	+2.93**	+1.51**
Utica Street	946	21 719	−30.72**	−25.74**
Summer-Best	365	18 889	−42.08**	−25.51**
Allen-Medical Campus	442	23 950	+13.69**	+4.91**
Theater Station	231	18 594	−27.26**	−22.61**
Fountain Plaza	77	18 125	+3.88	+27.03**
Lafayette Square	35	17 035	−2.02	−0.99
Church Street	<30	Insufficient n for estimation		
Seneca Street	<30	Insufficient n for estimation		
Erie Canal Harbor	<30	Insufficient n for estimation		
All stations	7357	26 295	+2.31**	+0.99**

Notes: **significant at the 95 per cent level or greater.

capitalised into housing values. The neighbourhoods in Buffalo are perhaps just too uneven for a traditional pattern (Giuliano, 2004) in which housing prices are highest near the central business district and experience spatial decay moving towards the suburbs.

We group the stations with statistically significant results by $10 000 intervals into high, medium, and low annual income, and average the effect of rail transit proximity on property values. The results are shown in Table 6. Contrary to findings in other metropolitan areas (Bowes and Ihlanfeldt, 2001; Nelson, 1999),

Table 6. Effect of proximity to light rail stations on property values by neighbourhood prosperity

Neighbourhood income category	Median household income $ (1999)	Number of Metro Rail stations	Stations	Average change in property value in dollars (per foot further from station): Straight-line distance	Walking distance
High	30 000 or more	2	Amherst Street, University	+6.49	+4.02
Medium	20 000–30 000	4	Allen-Medical Campus, Utica Street, Delavan-Canisius College, LaSalle	+2.77	+4.63
Low	Below 20 000	3	Fountain Plaza, Theater, Summer-Best	−34.67	−7.03

Notes: Certain stations are omitted from this table because model results are not statistically significant at the 95 per cent level: Lafayette Square and Humboldt-Hospital (both models), Fountain Plaza (straight-line distance model), LaSalle (network distance model). Average changes in property value are unweighted.

the largest positive effects in Buffalo are felt in high-income neighbourhoods and the largest negative effects are felt in low-income neighbourhoods. As in many Rustbelt cities, older homes and less in-demand neighbourhoods tend to be closer to the central business district (Quigley, 1979) and housing prices gradually increase as distance from the central business district increases in deference to traditional bid-rent models (Alonso, 1964; Mills, 1972; Muth, 1969) that place the highest value at the centre (Burchell *et al.*, 2002; Downs, 2004).

Actual versus Perceived Proximity to Rail Stations

There are two groups of residents who benefit from proximity to rail stations. One group of residents benefits from being geographically closer to a light rail station—measured by straight-line distance—although they may not necessarily use or depend on transit. These residents or owners have a sense of proximity to light rail transit and consider this proximity as a locational advantage to residential properties (Bae, 2002). The other group of residents benefits from being within convenient walking distance of a light rail station calculated along the street network and generally includes residents who actually use transit.

Our findings suggest that the straight-line distance models produce more positive effects on property values than the network distance models and that the model results have greater statistical significance. A greater premium for straight-line distance than for walking distance suggests that geographical distance to a transit station is perhaps more important in Buffalo than walking distance.

Conclusion

This study adds to the growing literature on the positive relationship between light rail transit and property values, and provides needed evidence for the interrelation between transit access and land values in a slow-growth city. We thus find support for Robert Cervero's (1984) decades-old warning that, although light rail transit in Buffalo was perceived as a necessity for urban revitalisation and had sufficient political backing, the lack of a strong regional economy would limit the power of Metro Rail to revitalise downtown and neighbourhoods (Knight, 1980).

The results of the all stations model suggests that, throughout the system, a typical home located within one-quarter of a mile of a rail station can earn a premium of \$1300–3000, or 2–5 per cent of the city's median home value.[17] Models for individual stations suggest that the greatest positive effect on price is felt at University station, where residents benefit from rail proximity in addition to other factors that positively influence property values, and the greatest negative effect on price is felt at Summer-Best station, where there is a significant negative premium associated with being close to a transit station in addition to other likely factors that negatively influence property values (Liggett *et al.*, 2001, 2003). An analysis of controlling factors suggests that three variables used in the models—the number of bathrooms (*BATHRMS*), size of the parcel (*AREA*) and location on the East Side of Buffalo (*EAST*)—are more influential than are rail proximity and other variables in predicting property value.[18] We thus find support for the hypothesis that proximity to stations increases property values, but the effect in Buffalo is weak, especially compared with growing West Coast and Sunbelt cities. Surely Buffalo is unique, though, in having a light rail route follow a low-income–middle-income and White–Black/African American dividing line.

Based on these findings we cannot claim that amid economic decline and population loss, light rail transit will unequivocally increase property values and revitalise depressed neighbourhoods. This is perhaps unsurprising, as previous research in Miami (Gatzlaff and Smith, 1993) and other places demonstrates that properties in neighbourhoods experiencing decline show no relative benefit in property values. Variation in the influence of transit on property values by neighbourhood type in Buffalo echoes findings in other cities as well (Gatzlaff and Smith, 1993).[19] Clearly, price premium patterns are not felt widely or evenly throughout the light rail system as it traverses through various neighbourhoods.

Like many proposals for capital expansion of transit facilities (Anderson, 1970), early studies for light rail transit in Buffalo justified the expenditure by citing indirect or non-user benefits (New York State Office of Planning Co-ordination 1969). Today, however, the existence of light rail in Buffalo influences land values only modestly—and negatively near three stations.

Where access to rail transit is not highly valued, property values do not rise. The analysis suggests that transit accessibility does not play a large role in property values in Buffalo. We conclude that the access advantages[20] provided by Buffalo's Metro Rail are not valued to the degree that proximity to transit produces price premiums in growing places such as Dallas (Weinstein and Clower, 2002), Portland (Chen *et al.*, 1998; Lewis-Workman and Brod, 1997; Al-Mosaind *et al.*, 1993), and San Diego (Landis *et al*, 1995; Cervero and Duncan, 2002a) or in certain high-income neighbourhoods in places like Atlanta (Nelson, 1992). This can be attributed to a lack of *regional* accessibility to employment centres (Diaz, 1999) and a lack of development within station areas throughout Buffalo. A fragmented planning process for Metro Rail in the 1960s and 1970s lacked co-ordination between New York State and the NFTA and local-level municipal planning; today, however, every effort should be made to co-ordinate transport and transit planning with land use.

We find little capitalisation of the light rail system into property values (Skaburskis, 1982) adjacent to Metro Rail stations and we attribute this, at least in part, to the limited extent of service. In the 20 years since light rail service began, the region has been unable to agree on how to proceed with a plan to extend Metro Rail.[21] This includes gaining taxpayer support, raising necessary funds and overcoming political discord (Hess and Lombardi, 2005; Lombardi, 2006). As a consequence, the 6.4-mile light rail line, which is only a *portion of the intended starter line* to the University at Buffalo Amherst campus, fails to provide *regional* accessibility.[22] Metro Rail riders have a one-seat transit ride only to destinations along the corridor; for other destinations in the city—and all destinations in the suburbs—Metro Rail riders must transfer to buses. While Metro Rail adequately serves an important mobility function for many residents—and particularly those without automobiles—it has little influence on *regional accessibility* and travel behaviour (Banister and Berechman, 2000).

On the bright side, we consider the lack of high price premiums near Metro Rail stations in Buffalo to be an enormous opportunity. In a region where no prospect to increase access, attract jobs, workers and residents, and encourage economic growth can be ignored, urban planners and municipal officials should exploit the existence of reasonably priced properties within many stable neighbourhoods adjacent to light rail stations and Metro Rail's relatively speedy service (7-minute headway during the peak), low fares and uncongested travel. The corridor's universities and colleges, medical laboratories and cultural institutions, which are solidly supported by affordable housing, can help to improve local and regional prosperity and quality of life.

Notes

1. For background about residential location theory, see Giuliano (2004) and Weisbrod *et al.* (1980).
2. Observers argue that the nine-year construction period—during which the 1.2-mile Buffalo Place pedestrian mall through the heart of downtown was impassable for all but pedestrians—dealt a fatal blow to the city's faltering economy, especially downtown retail enterprises, which are now nearly non-existent.
3. Figure created using population from the US Decennial Census. Population data before

1830 for Buffalo and before 1900 for Erie County are available from Buffalo and Erie County Public Library (2005). Population projection for 2010 for Buffalo from Office of Strategic Planning (2004) and for Erie County from New York Statistical Information System (2005).

4. The low property values in Buffalo are not expected to depreciate in the near future, as they might in a high-growth city such as Boston (Glynn, 2005).
5. A series of transit planning and environmental reports sequentially lowered the estimated number of daily weekday riders from 92 000 to 46 000 (Richmond, 2005; Voorhees and Associates, 1976). The number of average weekday unlinked trips peaked at 29 000 in the early 1990s and has now dropped by nearly 60 per cent.
6. The minimum station spacing (0.2 mile) is between Erie Canal-Harbor Station and Seneca Station and the maximum station spacing (1.1 miles) is between Humboldt-Hospital and Amherst Street.
7. Linear regression was performed because the distribution of data on a scattergram plot revealed no parabolic or exponential curve. Nevertheless, we experimented with both linear regression and linear-logarithmic transformation (of the assessed property value and distance to transit variables); for the majority of station-area models, the linear model had higher adjusted R^2 values. Furthermore, variables describing the built environment tend to perform better in linear models than in other types of specification, compared with variables describing economic characteristics, which perform better in logarithmic models (Targa and Clifton, 2005; Galea *et al.*, 2005). We therefore limit our discussion in this article to linear regression, the most parsimonious model specification. Although this article focuses on linear regression, other researchers have explored the relationship between property price and accessibility using both additive and multiplicative functional regression forms (Skaburskis, 1982).
8. For discussion of hedonic regression theory, see Freeman (1979) and Kain and Quigley (1970a). For examples of hedonic modelling in similar research contexts, see Bajic (1985), Ding *et al.* (2000), and Palmquist (1984).
9. A limitation of this study is the use of assessed property values instead of sale prices. Some observers argue that sales prices provide better data for the property value study; however, sale prices are available for only those parcels that have either been purchased or sold. In Buffalo's depressed economy, it would be difficult to amass a large number of sales transactions to study accurately the properties within a half-mile radius of transit stations. Despite this limitation, we used the assessed property data for the entire study; therefore, all properties in this research are subject to the same error if any exists. Our goal, however, is not to reveal actual assessed or sales prices, but to shed light on the magnitude of variations in property value throughout the light rail corridor.
10. While proximity to transit stations produces accessibility benefits, proximity to transit stations can simultaneously produce negative effects, such as noise, visual clutter and nuisance factors. This study, however, does not account for any negative effects arising from being close to the rail line, which is relevant for the at-grade sections of Metro Rail.
11. Clifton and Handy also assess several spatial analysis methods and report the following

    > Many accessibility measures make use of straight-line distances, or buffer distances . . . At the neighborhood scale, the choice between using straight-line distances and actual network distances can result in different assessments of the transportation environment. This is particularly true for pedestrian accessibility, where a discrepancy of one-quarter mile can influence the choice of whether to walk or drive to a destination (Clifton and Handy, 2001, p, 22).

12. *SINGLE* is a dichotomous variable coded 1 for all single family houses and coded 0 for all residential dwellings that cannot be defined as single-family. Similarly, *BASEMT* is a dichotomous variable coded 1 if a house has either a partial basement or a full basement and coded 0 for all houses that have no basement or a crawl-space basement.
13. The East–West variable is similar to Nelson's (1992) variable indicating whether properties near MARTA stations are located in low-income or high-income neighborhoods.
14. All parcels located in a particular census block group are assigned the occupancy rate and population growth rate of that block group.
15. Within the study area, 55 per cent of housing units are single family homes, 40 per cent are

two-family homes, 3 per cent are three family homes and 2 per cent are four or more family homes or buildings. Our sample thus captures 95 per cent of housing units in the study area.

16. With only one light rail route in the system, all stations experience the same level of service and service variations by day of week or time of day are consistent throughout the system.
17. The median house value is $59 300 (US Census 2000) and the mean assessed property value of the 7537 parcels in the sample is $70 380 (see Table 3).
18. Although the East Side of Main Street (*EAST*) variable is statistically significant in the models, we find inconclusive evidence in this study about the effect of race on property value, as the main focus of the research is physical characteristics of the built environment.
19. Negative externality effects of station proximity—noise, safety and aesthetics—may appear near Buffalo's above-ground stations, but we expect these to have no effect near below-ground stations, which are housed in station buildings with few immediately adjacent developed residential or commercial properties. Nor is increased vehicle and pedestrian traffic in station areas assumed to be a detractor.
20. In Buffalo, low-income households situated near light rail stations are more likely than high-income households to use transit and experience travel time saving from improved service. Higher-income households, however, are less likely to use transit and therefore less likely than low-income households to experience travel time savings from improved transit service, yet land cost is more affected by light rail proximity for high-income properties. Where residents do not experience a travel time improvement, property prices are not bid higher. The average commute time in the Buffalo metropolitan area is 21 minutes, one of the shortest in the nation for medium-sized cities (Hess, 2005; US Census 2000). The 6.4-mile length of Metro Rail can *itself* be traversed end-to-end in 21 minutes—not including walking time and waiting time—suggesting that light rail offers little time savings advantage over an auto trip for many travellers and for many trips.
21. Of the 13 cities that have built light rail systems since 1980, Buffalo is the only one to have built no extensions. Baltimore's light rail line has been extended three times since its original line opened in 1992 and Portland's light rail line has also been extended three times since its original line opened in 1986 (GAO 2001).
22. If Metro Rail were extended to key regional worksites and activity centres—including Niagara Falls and the Buffalo-Niagara International Airport—the advantages of living near a station would increase, and property price premiums would likely rise above those calculated in this study. Light rail extensions would also provide transit accessibility for a wider labour pool. Federal funds for rail extensions may be less available than they were decades ago, but the NFTA identified several corridors for "high-quality transit" capital projects—including bus rapid transit—in its "Strategic Transit Assessment" (NFTA 2001). Unfortunately, in a region with budget crises looming on nearly all fronts, a new capital transit project is not currently on the public agenda, and may not be given serious consideration for the foreseeable future. Because of the region's interjurisdictional "turf battles," lack of tax-sharing agreements, and increasing urban-suburban disparities (Fiscal Policy Institute 2003), many suburban municipalities disassociate themselves from the economic health of the central city. Among suburban workers in Erie County, 27 per cent have jobs in the city of Buffalo (Hess, 2005) and therefore should have direct interest in the quality of public transit, even if they do not regularly ride Metro Rail or work in the central business district.

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