Did the Hiawatha Light Rail Line Increase Single-Family Residential Property Values?

Adam Kent & Joseph Parilla

Introduction

In 2001, the City of Minneapolis began construction on the Hiawatha Light Rail Line, one of the largest mass transit projects in the history of Minnesota. Opened in June 2004, this twelve-mile, seventeen-station line connects Minneapolis's downtown with the Minneapolis-Saint Paul International Airport and the Mall of America. In addition to connecting major amenities, the Hiawatha Line runs through several of Minneapolis's residential neighborhoods. To the extent that light rail increases accessibility and decreases transportation costs for nearby residents, such effects should be capitalized into local property markets.[1] With this in mind, our paper examines the effect of the Hiawatha Light Rail Line on single-family residential property values between 1997 and 2006.

To our knowledge, this paper is the first to examine the relationship between light rail and housing markets in Minneapolis.[2] At a total cost of $715.3 million, the Hiawatha Line generated much controversy due to the substantial local public investment required. As a matter of policy, it is important to understand who bears the costs and receives the benefits from the Hiawatha Line. A portion of this analysis must account for housing value changes generated by proximity to this new transit amenity.

The remainder of this paper is structured as follows. First, we review the main methods of analysis, the primary effects of light rail, and the previous findings identified in the existing literature. Next, we discuss our unique methodology and outline our data, detailing our study area and time frame. Third, we detail our summary statistics and empirical model. A description of expected results and our specific regression specification follows. Fifth, we outline our

[1] See Previous Results section below.
[2] The Metropolitan Council and researchers at the University of Minnesota's Humphrey Institute have and/or are currently conducting similar research, however, we know of no written paper examining this relationship using regression analysis.

empirical results. Finally, we discuss the implications of our findings and end with a brief conclusion.

Literature

Estimation Methods

The literature focusing on spatial amenity capitalization into housing markets relies primarily on two methods of analysis. Most commonly, researchers implement a hedonic pricing methodology, which defines a property by its various characteristics. Specifically, a home's price is characterized as a function of its attributes: its physical amenities (square footage, number of bathrooms/bedrooms, age of building, etc), neighborhood amenities (median income, white-minority ratio, crime rate, etc), and spatial amenities (distance to CBD, distance to major interstate, etc). Typically, hedonic estimation analyzes detailed cross-sectional datasets, as regressions seek to control for all inputs currently affecting a home's price. Although the hedonic pricing method remains the most common approach to assessing the housing price capitalization of spatial amenities, the literature points to functional form, endogeneity, omitted variable, and multicollinearity issues related to this model.[3]

To the extent that hedonic estimation is limited by these issues, a repeat sales methodology – the other technique used commonly – may provide for more accurate measurement of spatial amenity capitalization. Pioneered by Bailey et al. (1963), repeat sales methodology estimates the effect of an exogenous amenity shock on home value by analyzing the change in a home's sales price over at least two transactions (before and after the shock).

[3] For detailed discussions and analyses of the various problems surrounding hedonic estimation see Cropper et al. (1988), Malpezzi (2002), and Sheppard (1999).

Assuming all other amenities do not change over the studied time period, the difference in sales price should reflect the capitalization of such an exogenous shock.[4]

The repeat sales methodology holds several advantages over a hedonic-based analysis. First, all housing price changes are grounded in real estate market transactions, which avoid the potential inaccuracy of third part assessors. Second, a less detailed dataset is required, as attributes are controlled for by the differencing out of all static inputs.[5] Such an advantage carries strong implications for econometric estimation, particularly in regard to functional form, endogeneity, omitted variable bias, and multicollinearity.

First, problems surrounding the hedonic functional form are assuaged in a repeat sales model, as the researcher has only to choose a form that relates relatively few attributes – typically one – to the change in sales price. Second, the endogeneity prevalent in hedonic regressions is effectively eliminated through the differencing out of all static attributes.[6] Third, omitted variable bias is reduced, as even the variables typically omitted in a hedonic regression due to data limitations (for instance, quality of wood used for a home's construction) are differenced out. Finally, multicollinearity is practically guaranteed to be eliminated due to the differencing out of all static inputs (Malpezzi, 2002).[7]

Several drawbacks to repeat sales methodology, however, exist. Most notably, the method fails to use the full breadth and range of available data, as only a small percentage of homes within any dataset will be sold multiple times (Wang & Zorn, 1999). This results in selection bias if units transacted multiple times are physically different than the greater housing

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[4] It is important to mention that the repeat sales methodology similarly defines a home's price as a function of its physical, neighborhood, and spatial characteristics, however, by looking at the change in the home's price, all static characteristics which are required for the hedonic specification are differenced out (Malpezzi, 2002).
[5] See footnote 2.
[6] For a more detailed analysis of hedonic edogeneity problems, see Malpezzi (2002) and Sheppard (1999).
[7] For instance, the number of bedrooms and the number bathrooms, which are highly correlated variables, are typically differenced out in a repeat sales model.

stock (Case & Shiller, 1987). Additionally, if the inputs in a home's value other than the studied amenity change over the time period, an estimation applying a repeat sales methodology will produce biased results (Malpezzi, 2002).

Effects of Light Rail

In theory, proximity to a transit stop can have two effects on property values. Because proximity to public transit may decrease transportation costs and increase accessibility to employment locations, entertainment, recreation, and other amenities, one expects utility maximizing rent seekers to bid up those properties and capitalize those benefits into the price of the property (Hess & Almeida 2007). Increased pedestrian traffic near stations may also attract new business and retail development. If there are residents who pay a premium to be within walking distance of shops, transit-oriented retail development may contribute to an overestimation of the premium placed on the light rail itself. Conversely, nuisance effects such as noise, unsightliness, pollution, traffic, and increased crime near transit stops may suppress prices on adjacent homes (Chen et al., 1998; Bowes & Ihlanfeldt, 2001).

The relative magnitudes of the accessibility and nuisance effects could vary depending on the characteristics of the surrounding neighborhood. The premium placed on accessibility will be greater in areas where residents depend more on mass transit. The potency of nuisance effects are a function of several factors including the change in pedestrian and vehicle traffic, the amount of crime, and the layout and design of the station stop area. Typically, nuisance effects are less pronounced in neighborhoods where congestion or crime are already commonplace (Bowes & Ihlanfeldt, 2001).

Previous Results

Results from previous studies are varied. San Francisco's BART system, Washington DC's Metro, and transit lines in Portland, Dallas, and Buffalo all are estimated to have positive effects on nearby residential property values (Landis et al., 1995; Damm et al., 1980; Al-Mosaind et al., 1993; Weinstein & Clower, 2002; Hess & Almeida 2007). However, Gatzlaff and Smith (1993) concluded that residential values were only weakly changed by Miami's Metrorail and studies in San Jose and San Diego found a decrease in property values (Hess & Almeida 2007).[8] These studies typically evaluate the effect of light rail on property values by comparing a half-mile adjacent area to a neighboring control area.

Results from individual studies are context-specific, and thus, difficult to apply from city-to-city. Nevertheless, two general methodological and empirical trends arise from the literature. First, the effect of proximity to light rail can depend on the type of distance measure calculated. Technological progress in GIS software has enabled researchers to calculate straight-line distances from parcels to light rail lines, station stops, downtowns, and other points of interest such as parks, lakes, and employment centers. Street networks, however, provide a more realistic measure of proximity than straight-line distance. A study of Buffalo's MetroRail found that the effect of light rail on home prices was larger when using straight-line distance than using network distance (Hess & Almeida, 2007). Second, studies examining how specific neighborhoods value light rail reveal that property value changes may occur unevenly across different neighborhoods. Home values in low-income neighborhoods increased in Atlanta while wealthier neighborhoods experienced the greatest appreciation in Miami, which suggests that the effect of light rail on neighborhoods is highly specific to the study city (Gatzlaff & Smith, 1993; Hess & Almeida, 2007).

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[8] For a more comprehensive literature review see Smith and Gihring (2004) or Parsons Brinkerhoff (2001).

Methodology

To study the Hiawatha Line's effect on single family property values, we apply a repeat sales framework, however, use estimated market values (EMVs) as the dependent variable. As discussed above, the repeat sales methodology carries several advantages over the traditional hedonic approach. Most importantly, the repeat sales method allows for a more parsimonious estimation, as all static independent variables are differenced out. The extent to which independent variables change over the studied period, however, will bias our results, as all control variables are assumed static (i.e. number of bedrooms, distance to amenities, and neighborhood characteristics). Nevertheless, this simplified model inherently remedies (to a varying extent) four econometric problems associated with the hedonic approach: functional form, endogeneity, omitted variable bias, and multicollinearity.

Our use of EMVs directly addresses a main critique of a repeat sales methodology. Specifically, by analyzing assessed values, our estimation avoids the potential for selection bias associated with homes sold multiple times in a short period. Furthermore, the number of observations in our dataset is maximized, as *all* parcels are assessed yearly. Such a dependent variable provides two benefits for estimation. First, the uniformity of observations allows us to analyze property value changes on a year-to-year basis. Second, the comprehensive nature of EMV data facilitates a more robust analysis of specific geographic areas.

A major drawback of our methodology nevertheless exists in the failure to directly capture market forces. The Minneapolis Assessor's Office conducts mass appraisals of every property in the city, using "construction, sales data, and neighborhood trends to establish valuation benchmarks in their appraisal work" (http://www.ci.minneapolis.mn.us/assessor/about-us.asp). Indeed, a third party determines EMVs – not utility-maximizing buyers and profit-maximizing sellers – however, assessed values do serve as proxies for market-determined prices.

Potential biases may exist in an analysis regarding the Hiawatha Line's effect on property values if the Assessor's Office attributed an arbitrary, non-market based premium to homes adjacent to station stops. According to City Assessor Matt Sandell, the introduction of light rail did not influence the standard appraisal process.[9] Instead, the effect on EMVs would occur through a change in sales trends, construction patterns, or neighborhood characteristics after the introduction of the Hiawatha Line.

Data

Data Methods

The Metropolitan Council provides shapefiles[10] of the Hiawatha Line and station stops, while the Center for Urban and Regional Affairs (CURA) supply the EMV and Minneapolis parcel data used.[11] We restrict our analysis to parcels that fall within two miles of a station stop and use the buffer function in ArcGIS to select the relevant parcels.[12] Through ArcGIS, we spatially represent these parcels and join via attribute to form a dataset with approximately 28,000 parcels.[13] As a result, each parcel is matched to its 2006, 2003, 2000, and 1997 EMV.[14]

Additionally, in order to calculate each parcel's specific distance from the light rail, we create a point shapefile from the parcel polygon shapefile. We then join this new shapefile to the

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[9] Interview with Matt Sandell. 5 May 2008.

[10] A shapefile is a geospatial vector data format for GIS software. Shapefiles spatially describe geometries: points, polylines, and polygons. These, for example, could represent water wells, rivers, and lakes, respectively.

[11] We are deeply grateful to Jeff Matson from CURA, who facilitated our use of this data and answered the many questions we had for him.

[12] It is important to note, geographically, the two-mile buffer used to select parcels extends into Saint Paul, however, due to data limitations Saint Paul parcels within two miles of a station stop are not included in the sample.

[13] Specifically, we join by the "Property ID" or "PID" attribute, which is the variable used to identify each parcel in Minneapolis. Approximately 1000 parcels are lost in this process, due to missing observations across the four years studied.

[14] It is important to note that there are inherent inaccuracies with GIS when presenting spatial data because it is only a *representation* of real space. Furthermore, accuracy decreases when GIS data is copied, cut, pasted, clipped, and intersected (Anderson, 2001).

station stop shapefile spatially, which automatically calculates the straight-line distance to the nearest station stop in meters. We assume that the straight-line distance will serve as a reasonable proxy for the true walking or driving distance to amenities. Furthermore, we use the buffer function in ArcGIS to create both distance dummy variables and station stop dummy variables, both of which are used in our regression analysis. Specifically, the distance dummy variables classify the parcel into a half mile, a half-to-one mile, a mile, or two miles from a station stop groupings. Similarly, the station stop dummy variables allow us to identify, for each parcel, the nearest station stop within a half-mile.

Study Area and Time Frame

To examine changes in property values before and after the introduction of the Hiawatha Line, we contrast EMV changes from 2003-2006 to a comparison period spanning 1997-2000. These time frames allow us to capture snapshots of property markets before, during, and after the construction of the Hiawatha Line. Our analysis focuses on seven of the seventeen station stops along the Hiawatha Line in Minneapolis. Specifically, these seven single-family residential home areas are concentrated around the Cedar Avenue, Franklin Avenue, Lake Street, 38th Street, 46th Street, 50th Street, and VA Medical Center stations stops (see Figure 1). The parcels surrounding Downtown Minneapolis (the four northern-most stops), along with the southern portion of the Hiawatha Line (6 stops) do not contain many single-family properties, and are thus not included in our study.

The two-mile sample offers a wide range of neighborhood types. Areas around the Cedar Avenue, Franklin Avenue, and Lake Street stations contain lower-income, immigrant populations at relatively higher densities. Moving southward, neighborhoods surrounding 38th Street, 46th Street, and 50th Street stations are lower-density, single-family areas. Given their proximity to the Lakes District and the Mississippi River, these neighborhoods are some of the most sought after in Minneapolis.[15]

Summary Statistics

Table 1 displays the EMVs for select samples (all parcels, half-mile buffer, and outside half-mile buffer) across the four different time periods. There are roughly 28,000 observations at the parcel level. Across our entire study area, the mean 2006 EMV is approximately $218,600, while the mean 1997 EMV is roughly $76,000. Inside both the half-mile buffer and the outside half-mile buffer, property values reveal a similar appreciation rate, as the average 2006 EMVs are nearly three times their 1997 counterparts.[16] It is important to note that the mean half-mile buffer EMV is significantly larger than the outside half-mile buffer mean EMV in all time periods.[17]

The mean 2003-2006 change in EMV for half-mile buffer parcels is roughly $51,000 (see Table 2). When compared to the outside half-mile buffer, these parcels experience a significantly larger increase in mean EMV across all time periods. This implies that throughout all years considered, parcels within the half-mile buffer were consistently valued higher than outlying parcels. When we consider the percentage change in EMV, however, parcels outside the half-mile buffer appreciate significantly *more* than those within. Surprisingly, such a relationship suggests that the Hiawatha Line had no effect on EMV for homes close to the light rail. Higher-income neighborhoods with more desirable amenities (Minneapolis's Lakes District) may explain the disparity between the two samples. To the extent that variation in the number and

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[15] See http://www.cura.umn.edu/M3D.php for more demographic and land use information for the neighborhoods surrounding the Hiawatha Line.

[16] The EMVs are not indexed to inflation (see Tables 1 and 2), and thus a comparison across time periods does not control for inflation. This, however, will not bias our regression results, as we concentrate on EMV changes across different geographic areas, but within similar time frames.

[17] This suggests that future analysis should consider the percentage change in EMV as a dependent variable in order to control for the disparity in parcel values across geographic regions.

quality of amenities across neighborhoods affects the change in EMV, our estimation of the Hiawatha Line's effect may be biased.

In comparison to the other three-year time periods, the 2000-2003 mean EMV changes experience the greatest increases. On average, homes across all samples appreciate more than double their 1997-2000 mean EMV change. Such a marked gain may be explained by the real estate boom beginning in 2000, which significantly lifted property values, home sales, and new development throughout Minneapolis (City of Minneapolis CPED, 2006). The subsequent slowdown and market saturation in 2005 not only helps explain the smaller mean change in 2003-2006 EMV, but may potentially bias a comparison of EMVs downwards. More specifically, the effect of light rail may be underestimated in our analysis because the introduction of the Hiawatha Line coincided with the overall slowdown in housing development and sales in Minneapolis (City of Minneapolis CPED, 2006).

Empirical Model

Similar to hedonic theory, we define the empirical model of a home's price (P_i^t) before light rail in period *t* by its structural (S_i), neighborhood (N_i), and spatial (L_i) characteristics[18]:

$$P_i^t = \alpha_0 + \alpha_1 S_i + \alpha_2 N_i + \alpha_3 L_i + \varepsilon_i \qquad (1)$$

Correspondingly, a home's price in period *t+1* (after light rail) is represented by the same structural, neighborhood, and spatial characteristics, along with the exogenous light rail amenity (LRT_i) and the error term (ϕ_i):

$$P_i^{t+1} = \delta_0 + \alpha_1 S_i + \alpha_2 N_i + \alpha_3 L_i + \beta LRT_i + \phi_i \qquad (2)$$

[18] Structural characteristics may consist of number of bedrooms and bathrooms, square footage, home age, etc. Neighborhood characteristics refer to neighborhood demographic variables, such as income level, race, education level, etc. Spatial characteristics capture a parcel's distance from local amenities, such as parks, lakes, employment centers, etc. ε_i represents the error term.

Applying a repeat sales framework, the difference between P_i^t and P_i^{t+1} is represented below, where the error term, $\gamma_i = \varepsilon_i - \phi_i$, and the constant, $\omega_0 = \alpha_0 - \delta_0$:

$$P_i^{t+1} - P_i^t = \omega_0 + \beta LRT_i + \gamma_i \quad (3)$$

Expected Relationships and Regression Specification

We expect the relationship between distance from the Hiawatha Line and the change in EMV to be nonlinear. Specifically, even though homes bordering the station stop have the greatest accessibility to light rail, negative effects ("nuisance effects") may dominate, as congestion and crime could potentially increase in bordering neighborhoods. Homes outside this immediate vicinity are expected to escape these nuisance effects while still benefiting from the decreased transportation costs provided by light rail proximity. As the distance to a station stop increases, however, the costs of accessing light rail transit grow, and at a certain point, the benefits of increased accessibility provided by light rail fall below these costs.[19]

Given this expected relationship, our regressions apply a polynomial functional form.[20] A general example is below:

$$chngEMV = \overset{(+)}{\beta_0} + \overset{(+)}{\beta_1} distLRT + \overset{(-)}{\beta_2} distLRT^2 + \varepsilon \qquad (4)$$

In general, we expect to find a concave relationship (see signs above equation), with EMV changes first increasing with distance (nuisance effects) and subsequently falling after a maximum point (increasing light rail access costs). This maximum, or "optimal point" should represent the largest change in EMV attributable to light rail, holding all else constant.[21] We

[19] The literature regarding the effects of LRT on home price generally assume benefits accrue within a half mile of station stops (see Literature section).
[20] In order to avoid potential downward biases, all regressions exclude from analysis observations that did not experience a change in EMV during the specific time period studied.
[21] For the remainder of this paper the optimal point/location is defined as the distance from a station stop where the change in EMV attributable to light rail proximity is maximized, holding all else constant.

expect the estimated constant (β_0) to be positive, as home values across the United States have grown throughout our studied time period.

Sample Specification and Comparison Periods

Similar to previous literature, we primarily focus on parcels within a half-mile of a station stop, and additionally estimate both station stop effects and the Hiawatha Line's effect on a control sample (parcels within a half-mile to mile from a station stop). Before detailing the half-mile sample, however, we expand our scope of analysis to include all parcels within two miles of a station stop. Analysis of the two-mile sample allows us to estimate the potential effects of light rail beyond the half-mile.

As previously mentioned, we focus on two periods of EMV change: 1997-2000 (before ground-breaking) and 2003-2006 (before and after completion). When compared to 1997-2000 regressions, we expect 2003-2006 regressions to exhibit a significantly different distance-EMV change relationship. In total, we are concerned with two comparisons within our regressions: (1) Are there significant differences in the relationship between distance to light rail and EMV change across time periods, and (2) What is the spatial pattern of this distance-EMV change relationship?

Results

All Parcels

Across the two-mile sample, both 1997-2000 and 2003-2006 regressions contain statistically significant distance and distance-squared coefficients, which are positive and negative respectively (see Tables 3-4 for full results). These results suggest that distance in both time periods is concavely related to the change in EMV (see Graph 2). An F-test reveals that indeed, the distance-EMV change relationship is not statistically different between the 1997-2000 and 2003-2006 time periods.[22]

Half-Mile Buffer

Contrary to the two-mile results, an F-test on the half-mile results reveals the distance-EMV change relationship is significantly different across time periods. Specifically, while the 1997-2000 regression is insignificant and slightly convex, the 2003-2006 regression reveals a significant and expected concave relationship between light rail proximity and EMV change. These findings are shown below in Graph A, where all half-mile buffer parcels' EMV changes are a quadratic function of distance from the nearest station stop. Such results suggest that there is significant difference across time periods, and in fact, the increased accessibility provided by the Hiawatha Line was capitalized in home values within a half-mile of station stops between 2003-2006. In contrast to these findings, the half-mile to mile buffer regression results are not statistically different across the two time periods (see Graph 3).

Turning to the spatial effects of the Hiawatha Line, we focus on the effect of distance from light rail on the 2003-2006 EMV change and find the optimal location to be roughly a third of a mile (553 meters) from station stops (see Table A). At this optimal location, we estimate that the Hiawatha Line increases a parcel's EMV change by nearly $16,000. Interestingly, within the half-mile buffer, the average distance between a parcel and the station stop is only 21 meters greater than the optimal distance. This implies that accessibility benefits from the Hiawatha Line were borne relatively equally amongst all parcels, with strikingly 30% percent of the property value change attributable to the introduction of light rail – a much greater percentage in relation to the two-mile sample. Furthermore, the 2003-2006 regression at the half-mile to mile area

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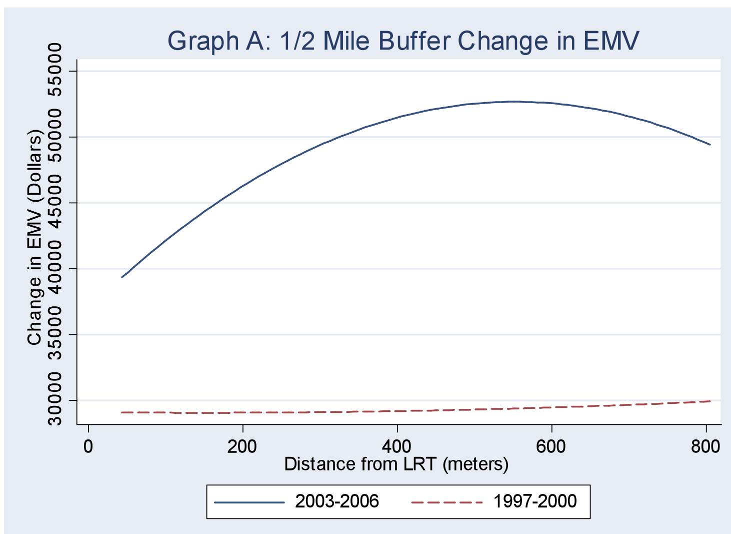
[22] Due to the constraints of a multivariate regression, F-tests mentioned throughout this paper exclude some observations from analysis. Specifically, observations that experienced no change in EMV in either one or both time periods are dropped. For F-statistics, see Table 3.

estimates insignificant distance coefficients, which suggests that the Hiawatha Line plays an insignificant role in the change in EMV outside this half-mile area.

Table A: Estimated Effects of LRT (2003-2006)

	1/2 Mile Buffer
Optimal Distance (meters)	553
Value Added at Optimal	$15,716
Mean Distance (meters)	574
Value Added on Average	$15,693
Percent of Change on Average	30%

*All figures are calculated from regression estimations in Table 3



Station Stops

Station stop effects may vary across stops, depending on the extent of mixed-use development or congestion caused by the Hiawatha Line. To analyze these potential varying effects of the light rail within the half-mile buffer, we estimate station-specific regressions (Table 4). Particularly, station stop regression results reveal that two stops – 50th Street and Cedar Avenue – have statistically different distance-EMV change relationships between time periods. Also, the distance coefficients in the Franklin Avenue regression maintain significance but are not significantly different between time periods. All other station stop regressions, however estimate an insignificant distance-EMV change relationship in 2003-2006. Taken together, these results suggest a lack of stop-specific effects within the half-mile or that a few neighborhoods are driving our overall results.

Discussion

In general, the regression results raise some questions regarding the effect of the Hiawatha Line on property values in Minneapolis. Our regressions including all parcels within two miles of a station stop are significant across both time periods, with the optimal location estimated nearly a mile away. The fact that a significant relationship between distance and EMV change exists pre-light rail (1997-2000), raises questions of possible omitted variable bias at the two-mile level (at the least). Additionally, it seems unrealistic to estimate significant results across all parcels, when analysis centering on the half-mile to mile area finds insignificant results (see Table 3). Furthermore, the calculated optimal location at the two-mile level (roughly a mile away) is situated within the half-mile to mile area – an area whose regression estimates *insignificant* distance coefficients (see "1/2 – 1 Mile Buffer" column in Table 3). These apparent contradictions, along with the implication of omitted variable bias, undermine the validity of analyzing the Hiawatha Line's effects on a two-mile level.

In contrast, the half-mile findings support our expectations. In particular, pre-light rail regression results are insignificant, while 2003-2006 regressions find a significant and concave relationship between distance and EMV change. Differing from the two-mile regression, this concave relationship estimates an optimal location *within* the half-mile buffer. Such results support the literature's general hypothesis, which proposes that the effects of light rail occur within a half-mile of station stops.

As discussed previously, the concave distance-EMV change relationship results from two effects: the negative nuisance effects and the positive effects of increased accessibility. In regard to our study area, both effects appear reasonable. First, numerous articles have both documented and attributed increased congestion in adjacent neighborhoods to the Hiawatha Line (Zdechlik, 2004; Juno, 2004). Cited congestion effects from the Hiawatha Line are two-fold. Since trains are given priority at intersections, traffic congestion has grown in areas surrounding the light rail (Juno, 2004). Furthermore, the absence of parking options for light rail riders driving to station stops has resulted in "hiding and riding" – a phenomenon where commuters effectively use nearby residential streets as parking lots for their daily commute (Zdechlik, 2004). Proximity to the Hiawatha Line also provides positive effects resulting from increased connectivity to desirable amenties. Specifically, the Hiawatha Line connects riders to employment centers (Minneapolis Central Business District), transit nodes (Minneapolis-St. Paul International Airport), along with shopping and entertainment destinations (Mall of America). The fact that ridership has already exceeded estimates for 2020 reveals that the benefits of increased accessibility provided by the Hiawatha Line are being fully realized.[23]

Conclusion

This paper is the first we know of to analyze the effect of the Hiawatha Line on residential property values in Minneapolis. Specifically, we employ a repeat sales methodology with estimated market values, to determine the relationship between distance from light rail and the change in home value. Using 1997-2000 as a comparison time period, our findings suggest that at the half-mile, the Hiawatha Line is responsible for an almost $16,000 increase in EMV. This amount is almost a third of the change in home value over the studied time period. While

[23] The Metropolitan Council: http://www.metrocouncil.org/transportation/lrt/lrt.html.

results outside the study area are either insignificant or clearly biased, regressions within the half mile suggest the capitalization of the Hiawatha Line's accessibility and nuisance effects.

Limitations, however, exist in our analysis. First, our study area is restricted in scope, as we include only Minneapolis parcel data. Since the Hiawatha Line runs close to the Minneapolis–St. Paul border, it remains quite possible that some St. Paul parcels additionally experience light rail's positive and negative effects. Second, it is apparent when we expand the study area beyond the half-mile, omitted variables influence our results. To the extent that spatial disaggregation alleviates this bias, future work should consider smaller, geographic-specific study areas, such as neighborhoods or school zones.[24] Third, the distance-EMV change relationship should be represented as a percent change, and especially over larger study areas, this change may be better explained through different estimation techniques. Particularly, a less-constrained functional form could provide greater insight into distance's effect on all Minneapolis property values. Additionally, the effect of distance may vary depending on the distance measurement (straight-line vs. street-line). Finally, time may ultimately determine light rail's capitalization into the housing market, as previous literature finds varying light rail capitalization time lags across cities. To provide for a more accurate analysis, future research must address these issues when estimating the Hiawatha Line's effect on residential property values.

[24] See Goodman & Thibodeau (2003) and Malpezzi (2002).

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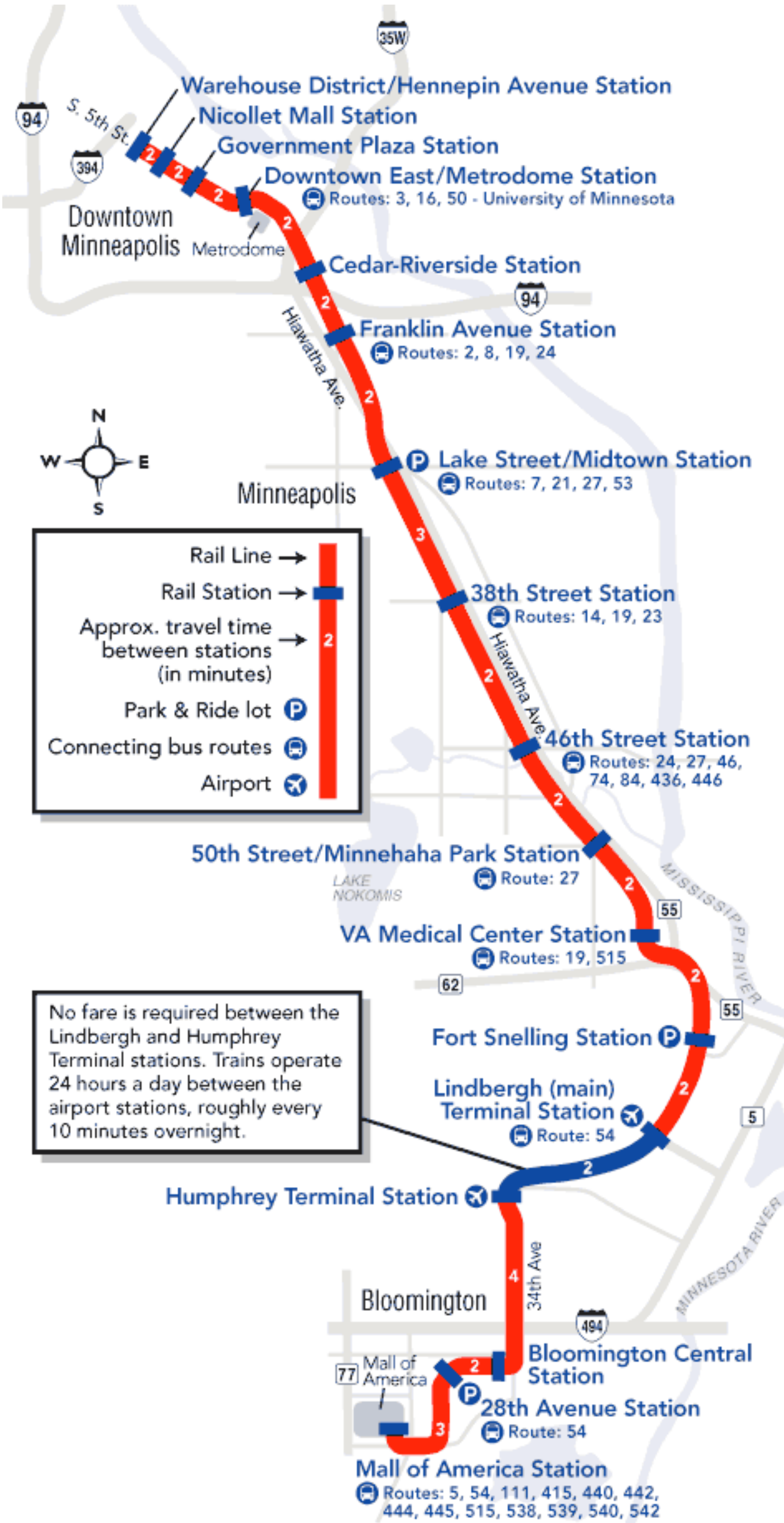


Figure 1: Hiawatha Line

Source: Metro Transit

Table 1: Summary Statistics (Estimated Market Values)

	Variable	Obs	Mean	Std. Dev.	Min	Max
All Parcels	2006 EMV	28391	218616.80	85832.25	43000	4100000
	2003 EMV	28391	168991.90	66584.89	32000	3750000
	2000 EMV	28391	103660.60	50663.12	25000	3900000
	1997 EMV	28391	76290.79	37752.17	25000	2900000
1/2 Mile Buffer*	2006 EMV	5770	233285.90	109080.10	85000	4100000
	2003 EMV	5770	182042.40	86930.46	38100	3750000
	2000 EMV	5770	113017.70	73746.50	26000	3900000
	1997 EMV	5770	83579.71	54798.34	25000	2900000
Outside 1/2 Mile Buffer*	2006 EMV	22621	214875.20	78376.98	43000	2316500
	2003 EMV	22621	165663.10	59855.14	32000	1831500
	2000 EMV	22621	101273.80	42501.90	25000	1332000
	1997 EMV	22621	74431.58	31716.26	25000	1200000

*1/2 Mile Buffer refers to parcels within 1/2 mile of a station stop

Table 2: Summary Statistics (Change in Estimated Market Values)

	Variable	Obs	Mean	Std. Dev.	Min	Max
All Parcels	EMV 2003-2006	28391	49624.91	27848.29	-230000	1054500
	EMV 1997-2000	28391	27369.78	17549.03	-46500	1000000
	EMV 2000-2003	28391	65331.36	24092.52	-150000	663500
	EMV 1997-2003	28391	92701.14	34507.63	-10000	949500
1/2 Mile Buffer*	EMV 2003-2006	5770	51243.45**	32612.91	-75000	1054500
	EMV 1997-2000	5770	29438.00**	21976.29	-21000	1000000
	EMV 2000-2003	5770	69024.70**	24952.96	-150000	439000
	EMV 1997-2003	5770	98462.69**	38274.82	-10000	850000
Outside 1/2 Mile Buffer*	EMV 2003-2006	22621	49212.06	26481.16	-230000	693500
	EMV 1997-2000	22621	26842.23	16185.91	-46500	780000
	EMV 2000-2003	22621	64389.29	23776.99	-86000	663500
	EMV 1997-2003	22621	91231.52	33320.77	-8500	949500

*1/2 Mile Buffer refers to parcels within 1/2 mile of a station stop

**All 1/2 Mile Buffer mean changes are significantly larger than the Outside 1/2 Mile Buffer mean changes

All EMVs are not indexed to inflation

Table 3: Regression Results

Change in Estimated Market Value

	All Parcels		1/2 Mile Buffer		1/2 - 1 Mile Buffer	
	2003-2006	1997-2000	2003-2006	1997-2000	2003-2006	1997-2000
Distance from LRT Stop	2.979	2.695	56.844	-0.587	-22.264	-34.809
	(3.16)**	(4.58)**	(3.88)**	-0.06	-1.85	(4.35)**
(Distance from LRT Stop)^2	-0.001	-0.002	-0.051	0.002	0.01	0.015
	(4.10)**	(9.07)**	(3.69)**	-0.21	(1.99)*	(4.56)**
Constant	48,401.60	28,049.88	36,962.78	29,098.86	60,706.93	47,653.67
	(68.55)**	(63.67)**	(10.12)**	(11.81)**	(8.71)**	(10.28)**
Observations	28384	28261	5770	5764	10064	10046
R-squared	0	0.02	0	0	0	0
F-Statistic	0.02		18.31		1.33	
Time Period Significantly Different?	No		Yes		No	

Absolute value of t statistics in parentheses
* significant at 5%; ** significant at 1%

Table 4: Regression Results (Station Stop Comparison)

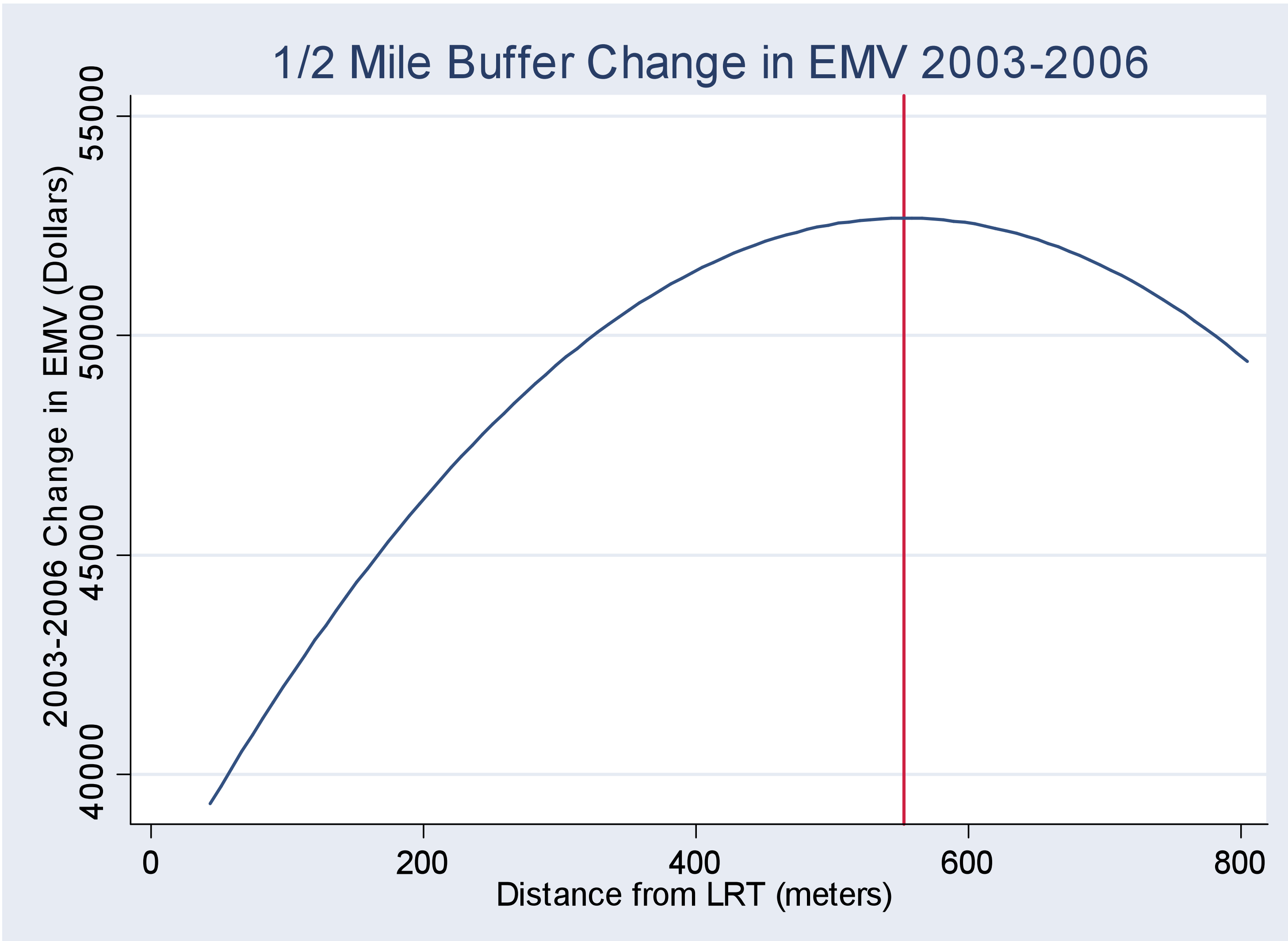
Change in Estimated Market Value

	2003-2006						
	38th St.	46th St.	50th St.	Cedar Ave.	Franklin Ave.	Lake St.	VA Med Center
Distance from LRT Stop	38.846	21.696	105.044	144.843	533.439	1.391	111.51
	-1.39	-1.46	(2.71)**	(2.38)*	(2.49)*	-0.02	-1.45
(Distance from LRT Stop)^2	-0.041	-0.011	-0.118	-0.139	-0.452	-0.005	-0.078
	-1.54	-0.76	(3.03)**	(2.30)*	(2.58)*	-0.07	-1.2
Constant	45,901.04	35,213.21	31,932.45	12,170.63	-87,518.95	59,639.96	15,910.57
	(6.69)**	(9.75)**	(3.55)**	-0.82	-1.38	(2.39)*	-0.72
Observations	1835	1567	890	99	350	496	533
R-squared	0	0.01	0.01	0.06	0.02	0	0.01
	1997-2000						
	38th St.	46th St.	50th St.	Cedar Ave.	Franklin Ave.	Lake St.	VA Med Center
Distance from LRT Stop	-22.006	-31.775	39.077	-89.093	273.57	-37.681	52.523
	-1.62	(3.27)**	(2.18)*	(2.40)*	(2.84)**	-0.3	-1.18
(Distance from LRT Stop)^2	0.014	0.045	-0.049	0.081	-0.244	0.025	-0.036
	-1.1	(4.84)**	(2.74)**	(2.19)*	(3.11)**	-0.22	-0.96
Constant	37,564.84	26,496.38	25,169.47	45,515.97	-39,950.77	52,304.23	13,560.45
	(11.28)**	(11.20)**	(6.05)**	(5.01)**	-1.4	-1.49	-1.05
Observations	1834	1566	888	99	348	496	533
R-squared	0.01	0.06	0.02	0.06	0.05	0	0.01
Time Period Statistically Different?	N/A	Yes	No	Yes	No	N/A	N/A

Absolute value of t statistics in parentheses
* significant at 5%; ** significant at 1%

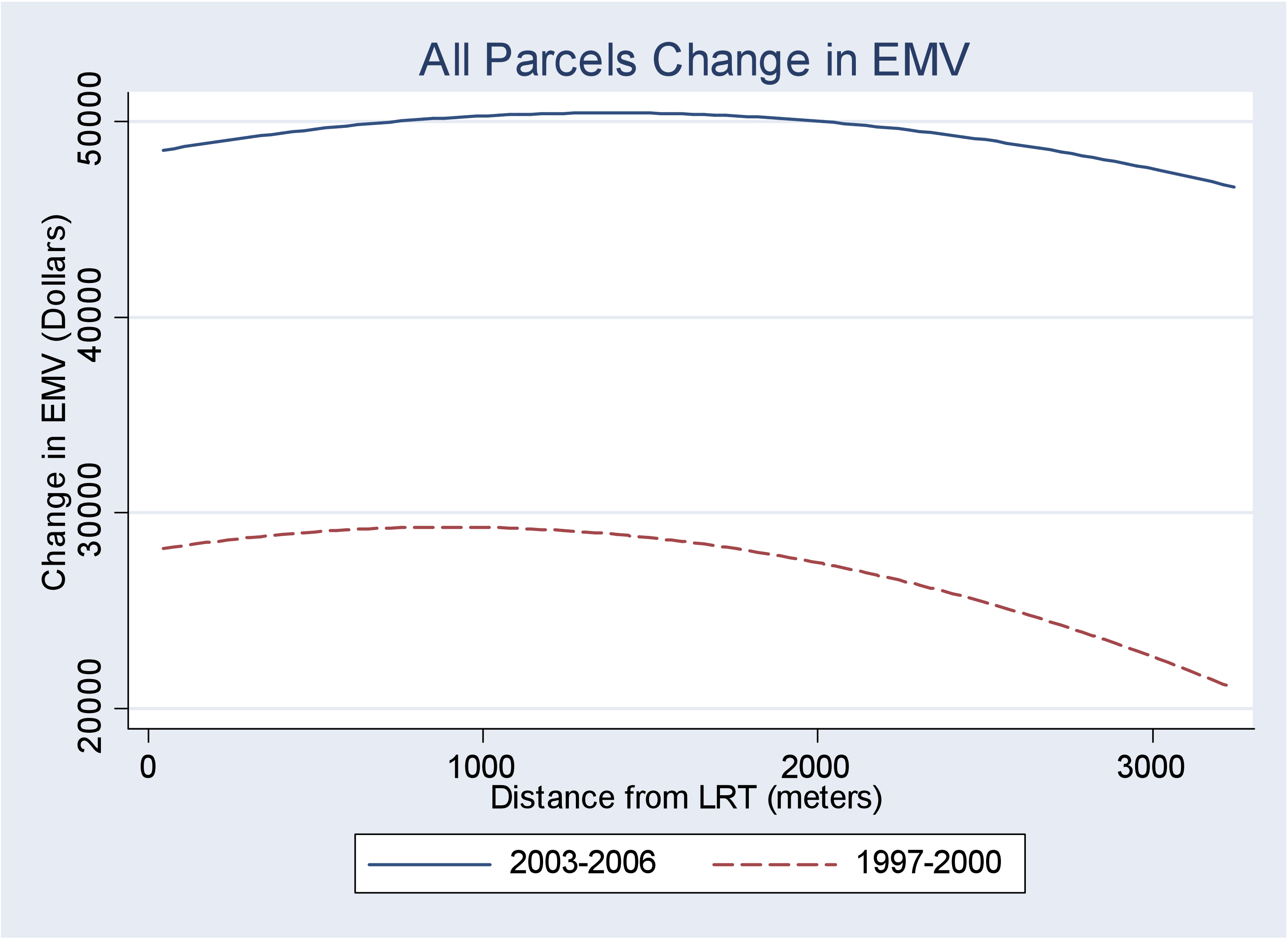
Regressions run on half-mile buffer sample

Graph 1

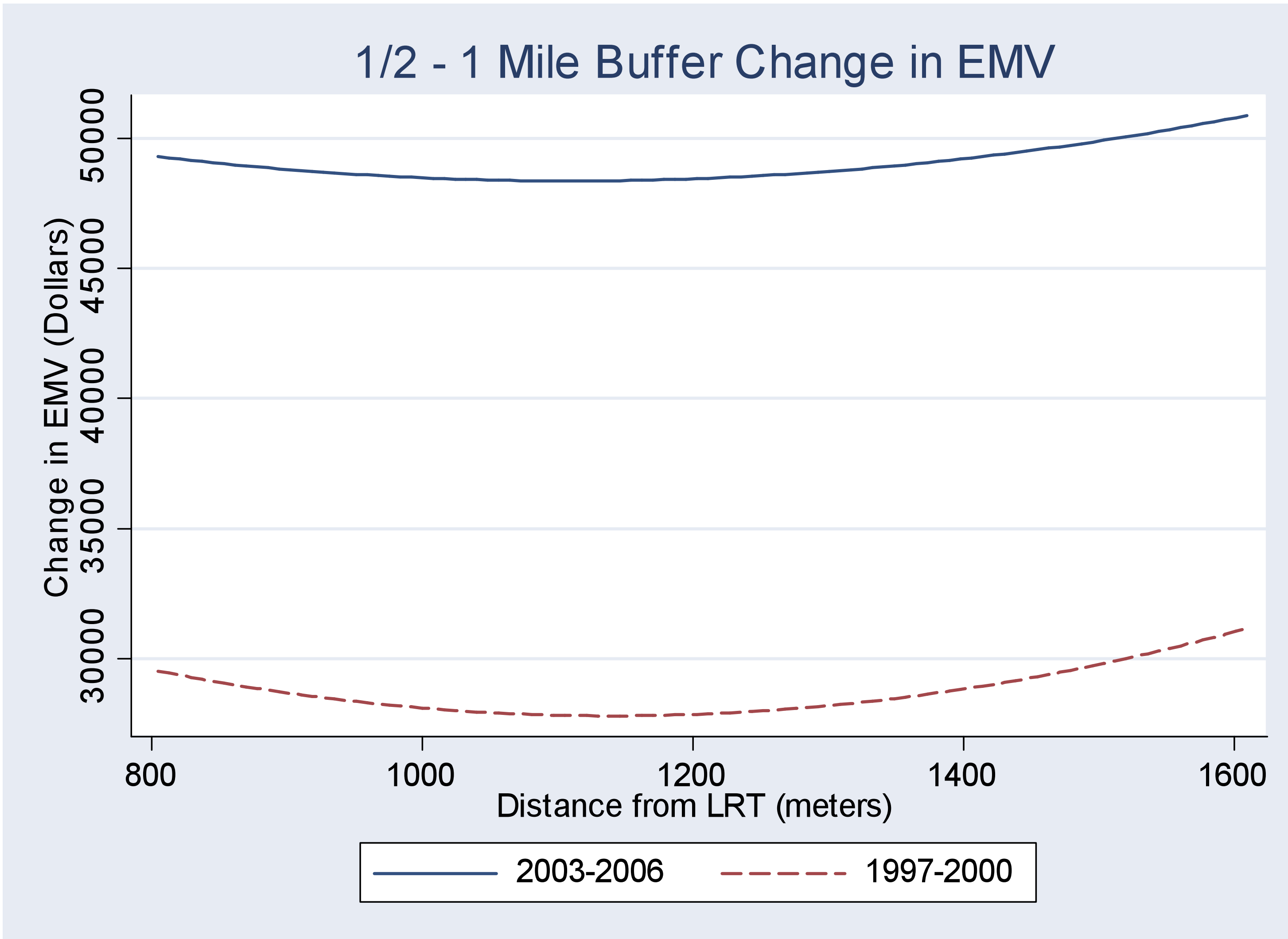


1/2 Mile Buffer Change in EMV 2003-2006
2003-2006 Change in EMV (Dollars)
40000
45000
50000
55000
0
200
400
600
800
Distance from LRT (meters)

Graph 2


All Parcels Change in EMV
Change in EMV (Dollars)
20000
30000
40000
50000
0
1000
2000
3000
Distance from LRT (meters)
2003-2006
1997-2000

Graph 3



1/2 - 1 Mile Buffer Change in EMV
Change in EMV (Dollars)
30000
35000
40000
45000
50000
800
1000
1200
1400
1600
Distance from LRT (meters)
2003-2006
1997-2000