The effect of anticipated transportation improvement on residential land values

John F. McDonald*, Clifford I. Osuji†

Department of Economics, University of Illinois at Chicago, 601 S. Morgan Street, Chicago, IL 60607, USA

Received May 1994; final version received October 1994

Abstract

This paper is an empirical study of residential land values in the vicinity of the new elevated transit line that runs the 11 miles from downtown Chicago to Midway Airport. The results show that in 1990 an increase of 17% in residential land values within one-half mile of the station sites can be attributed to improved access provided by the transit line. Alternatively, the increase was 1.9% (or $126.75 per lot) per mile of distance to downtown Chicago for those sites within one-half mile of the stations. The line opened on 31 October 1993, so the land market had begun to adjust well before the transit facilities were available for use.

Keywords: Urban transportation; Urban land values

JEL classification: R33

1. Introduction

The Southwest Side Rapid Transit Line opened in Chicago on 31 October 1993. Also known as the Orange Line or the Midway Line, the new line connects downtown Chicago to Midway Airport—a distance of 11 miles. The new line has been open for only a short time, but it had generated measurable effects on the value of real estate in its vicinity well before the

* Corresponding author.
† We thank two anonymous referees for their valuable comments.
opening date. The purpose of this paper is to document and measure these
effects on the market for residential land. This purpose is accomplished
through an empirical study of estimated land values that makes use of what
shall be called the generalized before-and-after method.

The Midway Line provides the first rapid transit service to the southwester-
ern quadrant of the city of Chicago. The other sectors of the city (southern,
western, northwestern, and northern) have had rapid transit service since
the turn of century or before, but the southwest side had been omitted.
Discussions of the possibility of a southwest side elevated line had taken
place since the 1940s, but the major transportation plan produced in 1962 by
the Chicago Area Transportation Study (CATS) once again omitted a
southwest side line. Instead an elevated line was proposed to run due East
from Midway Airport to connect with the old line that runs from downtown
to the south side of the city. In addition, CATS proposed an express bus
service for the Stevenson expressway, the highway that serves the southwest
side. McDonald (1988) provides a retrospective examination of the CATS
plan.

New discussions of a southwest side line were initiated in 1977, and the
intention to build a line was announced by Mayor Jane Byrne of Chicago in
1979 at the same time as she announced the cancellation of an expressway
project known as the ‘Crosstown Expressway’. At the time it was presumed
that federal funds for the cancelled highway project would be transferred to
the transit project, but this transfer of funds did not begin to take place for
another five years. As Krueger et al. (1980) and Anas (1982, 1983) discuss in
detail, in the period 1980–1983 several alternative alignments for the
proposed line were under consideration. The effects of various proposed
alignments on the housing market were simulated by Anas (1982, 1983); this
study is discussed in some detail below. A decision on the alignment finally
was made, and the first $32 million for property acquisition was received
from the federal government on 26 June 1984. According to local lore, after
he had provided critical support for one of President Reagan’s proposals,
southwest side Congressman William Lipinski was asked by the President if
there were anything he needed. The Congressman reportedly replied: “Mr.
President, have you ever heard of the Southwest Side Rapid Transit Line?”

The Midway Line was constructed at a cost of $410 million, and the
expense for rolling stock is an additional $111 million. The Federal Transit
Administration provided 85% of the cost, and the State of Illinois provided
the remaining 15%. The line is 11 miles in length, of which 9.2 miles is
newly built track (including 2.7 miles of elevated structure). The line has
eight stations outside the downtown area. The fare on the line is $1.50 for a
one-way trip; exact change, a token, or a pass is required. Token vending
machines are provided in the stations. Parking is available at three of the
four stations located the greatest distances from downtown at a price of
$1.50 for all day. These three parking lots contain a total of 800 parking spaces; the demand for these spaces reportedly already exceeds the supply at the price of $1.50. Ridership on the line was projected to be about 25,000 riders per weekday, and average actual ridership is about 28,000 per weekday. Typical travel time from Midway Airport to downtown is 30 minutes. Express bus service for the same trip during peak periods requires 45–50 minutes.

Given these basic facts about the Midway Line, we turn to the notion that the opening of the line had been anticipated in the residential land market. The plan of the paper is to discuss briefly the theory of housing prices and land values in the next section. The work of Anas (1982, 1983) and Anas and Duann (1985) is emphasized. Section 3 discusses the relationships between increases in housing rents, land rents, and land values. The timing of these increases is emphasized. Section 4 presents the generalized before-and-after method for the evaluation of urban transportation improvement projects. Section 5 discusses the data sources and presents the empirical results. Residential land values in the immediate vicinity of the station sites had responded in rather dramatic fashion by 1990. Section 6 summarizes the conclusions of the study.

2. Theoretical considerations

The Midway Line is an entirely new transit line that, in the southwestern quadrant of the city and nearby suburbs, replaces a bus service and also draws commuters who use the private auto. Does a transportation improvement of this magnitude require the construction of a general equilibrium model of transportation and land use, or will a partial equilibrium model suffice? And if a general equilibrium model is needed, should the metropolitan area be assumed to be open to migration or closed? These issues are discussed in this section.

Fujita (1989) and Polinsky and Shavell (1976) are the basic references for these theoretical issues.

The interpretation of the empirical results in this study is based on the assumption that only a partial equilibrium model is needed. The Midway Line creates improved access to the central business district around eight station sites. The residential land and housing markets around the station sites adjust accordingly, and it shall be assumed that the general equilibrium effects on the rest of the metropolitan area can safely be ignored. It is true that there will be some diversion of the housing supply and population to the vicinity of the Midway Line, but the magnitudes of these diversions are not likely to have appreciable impacts on any specific locations in the rest of the metropolitan area. Rather, the general equilibrium impacts are likely to
be small and diffuse within a metropolitan area of over seven million people.

The validity of the assumption that a partial equilibrium model is sufficient in this specific case was, in effect, tested by Anas (1982, 1983). Anas developed a large-scale general equilibrium model of transportation, housing, and residential location for metropolitan Chicago that was used to simulate the effects of the Midway Line on the housing market (and on modal choice, as well). One of the options for the Midway Line that was tested is very similar to the one that was actually built. The model is known as the Chicago Area Transportation/Land Use Analysis System (CATLAS), and is described briefly in the following paragraphs. The reader should consult Anas (1982) for a full description of the model.

As stated by Anas (1983), CATLAS is a dynamic model that simulates the housing market in recursive periods of one year in length for a grid system of 1,690 zones. On the demand side worker/residents with given work places are assumed to choose travel mode and residential location options. On the supply side housing owners maximize profits by deciding whether to rent an existing dwelling at the current rent or to leave the unit vacant for the time period. Owners of vacant land decide whether to build new housing or to wait, and owners of older housing decide whether to demolish the building and sell the land or to continue to supply housing. Housing rents adjust in each geographic zone each year, and these adjustments create incentives for supply responses in the next year. It turns out in the simulations that the choice of travel mode (i.e. switching from bus or auto to rapid transit) has the greatest impact on housing rent.

Anas (1982, p. 229) reported the results of the simulation performed for an option, known at that time as the Indiana Harbor Belt (IHB) project, that is similar to the actual Midway Line. The location of the actual Midway Line right-of-way is exactly the same as in the simulation. However, the project in the simulation differs from the actual Midway Line in two respects. The actual Midway Line extends only to Midway Airport, but the option in the simulation extends beyond the airport to the West for about 3.5 miles. Also, the simulated option includes one more station along the run from downtown Chicago to Midway Airport than does the actual Midway Line.

The simulation of the IHB project does not permit adjustments of the supply of housing; the quantity of housing at each location is exogenously given. However, later simulations reported by Anas and Duann (1985) permit the supply of housing to adjust by permitting owners of vacant land to build new houses and owners of older housing to demolish the building and sell the vacant land. Anas and Duann (1985, p. 55) state that, “The most notable result is that the transit project has a very small net influence on the housing stock changes.”
The effects of the Midway Line on housing rents predicted by the simulation of the IHB project have been tabulated for the portion of the line from downtown Chicago to Midway Airport, and the results are as shown in Table 1. These results suggest that the effects outside the Midway Line corridor are negligible, and that the empirically detectable effects on the housing market are likely to be confined to areas within one-half mile of the station sites. A further examination of the housing rent increases for zones within one-half mile of the stations reveals that the nine zones within 5 miles of downtown had an average increase of 13.5%, while the ten zones located from 5 to 10 miles from downtown had an average increase of only 7.2%. The empirical results reported below provide some evidence that the zones located at greater distances from downtown had the greater increases in estimated residential land values attributable to the Midway Line, a result that is consistent with the greater saving of commuting time to downtown. Note that Anas (1982) simulated housing rents, but not land rents or land values. We assume that these simulated increases in housing rents are permanent increases. The data available to us are estimated residential land values, so a major portion of our discussion will pertain to the relationship between permanent increases in housing rents at the time the transit line opens and land values, both on opening day and prior to opening day.

Is a 10% average increase in housing rents near the station sites a reasonable figure given the amount of commuting time that the worker can save? As indicated above, the Midway Line will save the commuter 15–20 minutes per trip from Midway Airport compared with riding the bus. However, the average commuter on the Midway Line does not ride the entire length of the line. Suppose that the average time saved per trip is 10 minutes, or 20 minutes per day. If the commuter travels 20 times per month, this translates into a monthly savings of 400 minutes. McDonald (1983) found that commuting time in metropolitan Chicago was worth on average about $2.00 per hour in 1972. The data used by Anas (1982) pertain to 1970, so the value of time saved is about $12.00 per month in 1970 dollars. The average rent in the zones within one-half mile of the station sites in the Anas (1982) simulation in 1970 was $84 per month. Time savings worth $12 per month might therefore be expected to cause rents to increase by about 14%.

<table>
<thead>
<tr>
<th>Distance to station</th>
<th>Average change in housing rent</th>
<th>Number of zones</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–1/2 miles</td>
<td>10.2%</td>
<td>19</td>
</tr>
<tr>
<td>1/2–1 miles</td>
<td>2.8%</td>
<td>34</td>
</tr>
<tr>
<td>1–2 miles</td>
<td>1.8%</td>
<td>42</td>
</tr>
<tr>
<td>2–4 miles</td>
<td>1.7%</td>
<td>33</td>
</tr>
<tr>
<td>Over 4 miles</td>
<td>−0.2%</td>
<td>Many</td>
</tr>
</tbody>
</table>
a figure that is fairly close to the 10% average figure obtained in the simulation.

Furthermore, there may be good reason to expect that Anas’s (1982) estimate is lower because not everyone who lives near the stations travels downtown; about 81% of total employment in metropolitan Chicago in 1970 was not located downtown (Anas, 1982, p. 196). Anas (1982, p. 47) pointed out that the housing market may not operate with full classical efficiency because landlords do not know the specific modal choice of those to whom they are renting. Tenants do not reveal this information. Tenants are price takers, but retain some of the travel savings if landlords do not have perfect information. If the housing market were operating with full classical efficiency, anyone who lived adjacent to a station who does not travel downtown would have to outbid those who do travel downtown, and thus pay housing rents that capture the entire travel cost saving. This line of argument might provide an explanation for the result in the simulation noted above that the smaller increases in housing rents adjacent to the stations occurred at the greater distances to downtown.

3. Housing rents, land values and timing with certainty

One of the main purposes of this study is to test the hypothesis that residential land values will reflect the transportation improvement prior to the opening of the transit line. Assume that the transit project is announced at some point in time, and it is completed \( j \) years later. In the simplest case the change in land value at a time prior to opening is

\[
\delta V_{t-i} = \delta V_t/(1 + r)^i = \delta R_t/\left(1 + r\right)^i,
\]

where \( t \) is the year in which the transit line opens, \( t - i \) is the year under study (\( i < j \) years prior to \( t \)), \( r \) is the real discount rate, and \( \delta R \) is the permanent change in land rent from time \( t \) forward. The facts about the transit line are known with certainty at time \( t - j \); the date of completion is known to be \( t \), and the features of the transit line are known (e.g. travel times and fares). Eq. (1) simply says that the addition to land value at time \( t \) is discounted back to time \( i \). Housing rents do not rise before opening day, but land values do rise in anticipation of the increase in housing rents; the housing rent–land value relation is one empirical implication of the model that we have not tested. Note that the elasticity of \( \delta V_{t-i} \) with respect to \( \delta R_t \) is unity, or

\[
(\delta V_{t-i}/\delta R_t)(R_t/V_{t-i}) = (R_t/V_{t-i})/(r + 1)^i = 1.
\]

As Muth (1964) showed, the change in land rent can be related to the
change in the rental price $p$ of a unit of housing services provided for one year by using neoclassical production theory. The standard neoclassical theory of urban housing production assumes that housing services in a small zone are produced according to the production function

$$H = f(K, L),$$

where $H$ is housing services and $K$ and $L$ are the stocks of capital and land employed in that zone. It is assumed that this production function has constant returns to scale and an elasticity of substitution of $\sigma$. The factor shares of capital and land are denoted $s_K$ and $s_L$, respectively. Assume that the housing and land markets are perfectly competitive so that each input is paid the value of its marginal product. A well-known result of this model is that

$$d \ln R/d \ln p = (\sigma + e_K)/(\sigma + s_K e_L + s_L e_K),$$

where $e_K$ and $e_L$ are the elasticities of supply of capital and land, respectively.

In one standard case $e_K$ is infinite, $e_L$ is zero, and the entire expression reduces to $1/s_L$. (Note that, if $e_K$ is infinite, the values for $\sigma$ and $e_L$ do not matter.) If the share of land in housing production is 20%, then land rent should increase by five times the increase in housing rent. However, if $e_K$ is something less than infinity, the $d \ln R/d \ln p$ can be something less than $1/s_L$. For example, if residential zoning constrains the density of residential development to remain at its level prior to the announcement of the transit project, then $e_K$ in effect is zero and

$$d \ln R/d \ln p = \sigma/(\sigma + s_K e_L),$$

which reduces to 1 if $e_L = 0$. Indeed, if $e_L > 0$, then $d \ln R/d \ln p < 1$. Also, it is not unreasonable to suspect that loans and, hence, capital are not supplied with perfect elasticity to inner-city areas such as the southwest side of Chicago. Given the nature of the mortgage market in urban areas, it may be that more capital is available only if housing suppliers are willing to pay a higher price. In short, the elasticity of supply of capital (or zoning constraints on the capital–land ratio) plays a critical role in determining the impact of increases in housing rents on land values.

Now consider the numerical values from Section 2; the average housing rent is $84 per month and the increase in rent is $8.40 (10%) according to Anas (1982) or $12.00 according to our estimate of travel time savings. Assume that the real interest rate is 5% and that, following McDonald (1981), the share of land in the production of housing is 20%. Given these figures, initial land rent for the housing unit in question is $16.80 per month, and the value of the land is $4,032.

The increase in the value of land at time $t$ is found as follows:
\[ \frac{\delta V}{\delta R} \frac{\delta R}{\delta p} \delta p = \delta p \left( \frac{1}{r} \right) \frac{(R/p)(\sigma + e_k)}{(\sigma + s_L e_k)}, \]  

(6)

where it is assumed that the elasticity of supply of land in a small zone is zero. The best empirical evidence (McDonald, 1981, and Thorsnes, 1994) indicates that \( \sigma = 1 \). The elasticity of supply of capital shall be assumed to be 1, 2, 5, or infinity. The increases in the value of land in percentage terms given housing rent increases of $8.40 or $12.00 per month are shown in Table 2. The corresponding projected increases in the value of land three years prior to the opening of the transit line are computed as in Eq. (1) and are also shown in Table 2. The rent increase of $8.40 per month (10%) implies increases in land value three years prior to opening of 14% to 43%, depending upon the value of the elasticity of supply of capital. The rent increase of $12.00 per month (14.3%) implies land value increases of 21% to 62% three years prior to opening. (Note that, if the elasticity of supply of capital is infinite, the percentage increase in land value on opening day is simply the percentage increase in housing rent times \( 1/s_L \).)

If the facts about the transit line are not known with certainty at time \( t-j \) (or at time \( t-i \)), then the model should be modified. For example, the date of completion ex ante may have a probability distribution of some sort. In addition, the fare schedule and travel times for the new transit line may be uncertain. The presence of such uncertainty would reduce the amount a risk-averse potential buyer of land would bid at time \( t-j \); the discount rate

<table>
<thead>
<tr>
<th>Housing rent increase (( \delta p ))</th>
<th>Elasticity of supply of capital (( e_k ))</th>
<th>Land value increases (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Opening day</td>
<td>Three years earlier</td>
</tr>
<tr>
<td>$8.40 (10%)</td>
<td>1</td>
<td>16.7</td>
</tr>
<tr>
<td>8.40</td>
<td>2</td>
<td>21.4</td>
</tr>
<tr>
<td>8.40</td>
<td>5</td>
<td>30.0</td>
</tr>
<tr>
<td>8.40</td>
<td>infinite</td>
<td>50.0</td>
</tr>
<tr>
<td>$12.00 (14.3%)</td>
<td>1</td>
<td>23.8</td>
</tr>
<tr>
<td>12.00</td>
<td>2</td>
<td>30.7</td>
</tr>
<tr>
<td>12.00</td>
<td>5</td>
<td>42.9</td>
</tr>
<tr>
<td>12.00</td>
<td>infinite</td>
<td>71.5</td>
</tr>
</tbody>
</table>

* Computations for land value increase on opening day are based on Eq. (6) in the text:

\[ \delta V/\delta p = \delta p \left( \frac{1}{r} \right) \frac{(R/p)(\sigma + e_k)}{(\sigma + s_L e_k)}, \]

with \( r = 0.05 \), \( p = $84 \times 12 = $1008 \), \( s_L = 0.2 \), \( R = 0.2 \), \( p = $201.6 \), \( \sigma = 1 \), and \( V = R/r = $4032 \).

Computations for land value increase 3 years earlier are:

\[ \delta V_{t-3} = \delta V_t/(1+r)^3. \]
in Eq. (1) would include a risk premium. Furthermore, it is likely that the uncertainty declines as time passes and more information is available.

4. A generalized before-and-after evaluation method

The empirical estimation of the effect of an actual transportation improvement on residential land values requires a statistical model that controls for other possible influences on land values. A simple before-and-after comparison will likely produce biased results. Furthermore, cross-section analysis of only the ‘after’ period will also likely generate biased estimates.

Suppose that residential land values are determined in the ‘before’ period prior to the announcement that the transportation improvement will be built according to

\[
\ln V_b = \beta_0 + \beta_1 X_{1b} + \ldots + \beta_n X_{nb} + \delta_b D + e_b ,
\]

where \( V_b \) is land value on a block (with subscript for block omitted), \( X_{1b} \) through \( X_{nb} \) are various variables that influence \( \ln V_b \), \( \beta_0 \) through \( \beta_n \) are coefficients, \( D \) is proximity to the future sites for stations on the transit line, \( \delta_b \) is a coefficient, and \( e_b \) is a normally distributed error term with zero mean and constant variance. Note that it is assumed that the \( X \) variables take on values that are specific to the ‘before’ period. However, some of these variables (such as distance to the central business district, etc.) have the same numerical values in the ‘before’ and ‘after’ periods. And note that the model assumes that \( \ln V_b \) might be related to proximity to the transit station sites in the ‘before’ period; i.e. \( \delta_b \) might be different from zero. Obviously in the ‘before’ period land values cannot be related to proximity to station sites for the reason that they will become station sites, because such information is not available. But there might be other factors, such as proximity to employment or shopping or other local factors, that generate a relationship between \( \ln V_b \) and \( D \). This possibility should not be ruled out beforehand.

The equation for residential land values after the nature of the transit project is fully known is assumed to be

\[
\ln V_a = \alpha_0 + \alpha_1 X_{1a} + \ldots + \alpha_n X_{na} + \delta_a D + e_a ,
\]

where the ‘a’ subscript attached to variables refers to the values of the variables in the ‘after’ period, \( \alpha_0 \) through \( \alpha_n \) are coefficients in the ‘after’ period, and \( \delta_a \) is the coefficient of proximity to the transit stations. The statistical model represented by Eqs. (7) and (8) permits all variables to have different effects on land values in the two periods. The effect of the transportation improvement in partial equilibrium in percentage terms is
measured as $\delta_a - \delta_b$, the change in the effect of proximity to transit station sites. The standard error of this net effect is

$$\sigma_n = \left(\sigma_a^2 + \sigma_b^2 + 2\sigma_{ab}\right)^{1/2},$$

(9)

where $\sigma_a$ is the standard error of $\delta_a$, $\sigma_b$ is the standard error of $\delta_b$, and $\sigma_{ab}$ is their covariance. Following Eqs. (1), (7) and (8), the percentage change in land values at time $a$ attributable to the transportation improvement can be written

$$\delta V_a / V_a = \delta_a - \delta_b = \delta V_t / V_a (1 + r)^{t-a},$$

(10)

where $t - a$ is the number of years prior to the opening of the transit line.

Several restrictive assumptions will cause a simple before-and-after comparison to yield unbiased results. Suppose that proximity to the transit station sites is measured simply as a dummy variable (1 for proximate, 0 otherwise). Let us assume that $\beta_1 = \alpha_1, \ldots, \beta_n = \alpha_n$ and that $X_{1a}, \ldots, X_{nb} = X_{na}$. Given these restrictive assumptions, we can write

$$\ln V_a - \ln V_b = (\alpha_0 - \beta_0) + (\delta_a - \delta_b)D + e_a - e_b.$$  

(11)

The percentage change in land values simply consists of a general inflation factor $(\alpha_0 - \beta_0)$ and the added change associated with proximity to the station sites $(\delta_a - \delta_b)$. (Note that this simple before-and-after method can be used provided that a control group of blocks has been selected to provide an estimate of the general inflation in land values.) In general, the problem with the simple before-and-after method is one of specification error through the omission of variables. The omission of relevant variables leads to bias of unknown direction and magnitude in the estimated coefficients of the included variables and can also lead to an overestimate of the variance of the error term. The point is that the issue is an empirical question, to which we turn in the next section.

The cross-section estimation of Eq. (8) will yield an estimate of $\delta_a$, which is an unbiased estimate of the partial equilibrium effect of the transit project if $\delta_b = 0$, i.e. if there is no pre-project effect of proximity to station sites on land values. The empirical tests reported in the next section include results for all three methods—the simple before-and-after method, the cross-section method, and the generalized before-and-after method. The empirical results show that the simple before-and-after approach and the cross-section approach do produce some bias in this case, but that the biases are not statistically significantly different from zero.
5. Data sources and empirical results

The data source for residential land values, and the source for the identification of residential blocks, is *Olcott's Land Values Blue Book of Chicago and Suburbs* (Olcott, 1981, 1991). This source is issued annually and provides an estimated land value for each block in most of metropolitan Chicago. The estimates are based on actual sales of land and improved real estate, appraisals, and asking prices. The data source has been used in numerous studies in the past, including Yeates (1965), Hoyt (1933), McDonald and Bowman (1979), and McMillen and McDonald (1991, 1993). This study uses front-foot land values in 1980 and 1990 for residential lots of standard depth, which is 125 feet in the city of Chicago (i.e. the values are in units of dollars per 125 square feet). Because the simulation results of Anas (1982, 1983) show that land value changes attributable to the Midway Line are not expected to occur beyond 2 miles from the stations, a sample of 79 residential blocks located up to 3 miles from the Midway Line was chosen.

The years 1980 and 1990 were chosen because these are the most recent decennial census years. Data from the census on racial composition, median household income, and population density were gathered for the two years. The data base also includes measures of proximity to downtown Chicago, a major southwestern arterial street (Archer Avenue), a major shopping center (Ford City), an industrial site, and a park or school. Finally, distance to the transit station sites and straight-line distance to the Midway Line were measured. Mean values for all variables used in the study for 1980 and 1990 are shown in Table 3.

The year 1980 is taken as the ‘before’ time period. As recounted above, the intention to build the Midway Line had been announced by Mayor Byrne in 1979, but it was not until 1984 that a specific alignment had been chosen and funds made available for the project. In 1980 the public knew that a Midway Line might eventually be built, but the construction of the line was not a certainty and the sites for stations were unknown. The year 1990 is used as the ‘after’ year because the Midway Line was under construction at this time, the station sites were known, and the completion date of 1993 had been announced. Indeed, the stations were under construction and visible in 1990.

The first statistical test is the simple before-and-after comparison corresponding to the formulation in Eq. (11). The before-and-after data can be pooled to estimate \( \alpha_0, \alpha_0 - \beta_0, \delta_a, \) and \( \delta_a - \delta_b \). The estimated equation is

\[
\ln V = 5.234 + 0.640T + 0.072D + 0.143DT .
\]  
(12)

where \( T \) is a dummy variable for 1990 (equal to 1 for 1990, zero for 1980),
Table 3
Variable definitions and means for 1980 and 1990

<table>
<thead>
<tr>
<th>Variable</th>
<th>1980</th>
<th>1990</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land value per front foot</td>
<td>$204.56</td>
<td>$423.73</td>
</tr>
<tr>
<td>Distance to</td>
<td>6.85</td>
<td>6.85</td>
</tr>
<tr>
<td>Downtown Chicago (miles)</td>
<td>3.73</td>
<td>3.73</td>
</tr>
<tr>
<td>Major shopping center (Ford city)</td>
<td>0.77</td>
<td>0.77</td>
</tr>
<tr>
<td>Major arterial street (Archer Avenue)</td>
<td>0.52</td>
<td>0.52</td>
</tr>
<tr>
<td>Midway Line</td>
<td>0.62</td>
<td>0.62</td>
</tr>
<tr>
<td>Within 1/2 miles of</td>
<td>0.11</td>
<td>0.11</td>
</tr>
<tr>
<td>Industrial site</td>
<td>0.16</td>
<td>0.16</td>
</tr>
<tr>
<td>Park or school</td>
<td>0.37</td>
<td>0.37</td>
</tr>
<tr>
<td>Midway Line station</td>
<td>8.97</td>
<td>8.59</td>
</tr>
<tr>
<td>Population density per 20,000 sq. ft.</td>
<td>18.36</td>
<td>29.03</td>
</tr>
<tr>
<td>Percent black population in block group</td>
<td>1.00</td>
<td>6.00</td>
</tr>
<tr>
<td>Median household income in block group ($1,000)</td>
<td>18.36</td>
<td>29.03</td>
</tr>
<tr>
<td>Sample size</td>
<td>79</td>
<td>79</td>
</tr>
</tbody>
</table>

and $D$ is the aforementioned dummy for location within one-half mile of a station site. Unsigned $t$-values are in parentheses, and the $R^2$ is 0.442. The sample consists of 79 observations for 1980 and 79 for 1990. The intercept term is the estimate of $\alpha_0$, the coefficient of $T$ is the estimate of $\alpha_0 - \beta_0$, and the coefficient of $D$ is the estimate of $\delta_a$. The coefficient of $DT$ is $\delta_a - \delta_b$, the simple before-and-after estimate of the effect of the transit line on residential land values. The coefficient of 0.143 means that a 15.4% increase in land values can be attributed to proximity to the transit station sites; $0.143 = \ln(1 + i)$, where $i$ is the percentage increase in question. However, this effect is statistically significant only at the 85% level for a one-tail test.

The complete estimated log land value functions for 1980 and 1990 are shown in Table 4. Previous research by Yeates (1965) and McDonald and Bowman (1979) has found statistically significant nonlinearity between log land value and distance to downtown Chicago, so distance to downtown Chicago is entered as a quadratic function. Statistically significant non-linearity is found for both 1980 and 1990. Land values decline with distance to downtown in the vicinity of downtown, but at some point land values start to rise with distance. The estimated equation in column 1 of Table 4 implies that land values in 1980 reached a local minimum at a distance of 7.4 miles, and the coefficients in column 2 of Table 4 imply that the local
Table 4
Land values in the Southwest Transit Corridor: 1980 and 1990 (dependent variable is natural log of land value)

<table>
<thead>
<tr>
<th>Independent variable</th>
<th>1980</th>
<th>1990</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>7.757</td>
<td>10.775</td>
</tr>
<tr>
<td></td>
<td>(8.49)</td>
<td>(12.06)</td>
</tr>
<tr>
<td>Distance in miles to</td>
<td></td>
<td></td>
</tr>
<tr>
<td>downtown Chicago</td>
<td>-0.499</td>
<td>-1.006</td>
</tr>
<tr>
<td></td>
<td>(2.82)</td>
<td>(6.02)</td>
</tr>
<tr>
<td>Major shopping center</td>
<td>-0.155</td>
<td>-0.284</td>
</tr>
<tr>
<td>(Ford City)</td>
<td>(2.10)</td>
<td>(4.17)</td>
</tr>
<tr>
<td>Major arterial street</td>
<td>-0.22</td>
<td>-0.184</td>
</tr>
<tr>
<td>(Archer Avenue)</td>
<td>(0.29)</td>
<td>(2.58)</td>
</tr>
<tr>
<td>Midway Line</td>
<td>-0.038</td>
<td>0.244</td>
</tr>
<tr>
<td></td>
<td>(0.24)</td>
<td>(1.54)</td>
</tr>
<tr>
<td>Distance to downtown</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chicago squared</td>
<td>0.034</td>
<td>0.064</td>
</tr>
<tr>
<td></td>
<td>(2.85)</td>
<td>(5.65)</td>
</tr>
<tr>
<td>Within 1/2 miles of</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Industrial site</td>
<td>0.223</td>
<td>0.398</td>
</tr>
<tr>
<td></td>
<td>(1.76)</td>
<td>(3.34)</td>
</tr>
<tr>
<td>Park or school</td>
<td>0.153</td>
<td>0.097</td>
</tr>
<tr>
<td></td>
<td>(1.50)</td>
<td>(1.00)</td>
</tr>
<tr>
<td>Midway Line station</td>
<td>-0.046</td>
<td>0.114</td>
</tr>
<tr>
<td></td>
<td>(0.52)</td>
<td>(1.34)</td>
</tr>
<tr>
<td>Population density</td>
<td></td>
<td></td>
</tr>
<tr>
<td>per 20,000 sq. ft.</td>
<td>-0.025</td>
<td>-0.022</td>
</tr>
<tr>
<td></td>
<td>(2.14)</td>
<td>(1.86)</td>
</tr>
<tr>
<td>Percent black</td>
<td></td>
<td></td>
</tr>
<tr>
<td>population in</td>
<td>-2.730</td>
<td>-0.481</td>
</tr>
<tr>
<td>block group</td>
<td>(2.16)</td>
<td>(2.34)</td>
</tr>
<tr>
<td>Median household</td>
<td></td>
<td></td>
</tr>
<tr>
<td>income in block group</td>
<td>0.002</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>(0.14)</td>
<td>(0.06)</td>
</tr>
<tr>
<td>( R^2 )</td>
<td>0.412</td>
<td>0.676</td>
</tr>
<tr>
<td>( R^2 (adj.) )</td>
<td>0.316</td>
<td>0.623</td>
</tr>
<tr>
<td>Sample size</td>
<td>79</td>
<td>79</td>
</tr>
</tbody>
</table>

*Unsigned t-values are in parentheses.*

minimum for 1990 was located at a distance of 7.9 miles. The rise in land values with distance to downtown beyond these distances may be caused by access to Midway Airport and nearby employment centers and/or unmeasured negative neighborhood effects in the vicinity of the local minima.
Several other variables have the anticipated effects on residential land values. Column 1 of Table 4 shows that for 1980 distance to a major shopping center, population density and percent black population have statistically significant negative effects. In addition, distance from an industrial area and a park or a school have positive effects that are of marginal statistical significance. Distance to a major street (Archer Avenue), real median household income in the block group, proximity to a future Midway Line station site, and distance from the Midway Line right-of-way are not statistically significant. This result for income was not expected; income was expected to have a positive effect on residential land values.

The results for 1990 are shown in column 2 of Table 4. Distance to a major shopping center and the major arterial street have the expected negative effects, the expected negative effects emerge for population density and percent black population, and distance from an industrial area has the expected positive effect. Proximity to a park or a school and income do not have statistically significant effects. Distance from the Midway Line itself has a positive effect that is marginally statistically significant \((t = 1.54)\), and proximity to a Midway Line station has a positive effect that is also marginally statistically significant \((t = 1.34)\).

The results in Table 4 imply that the net increase in land values for residential sites within one-half mile of a Midway Line station is 0.160, which translates into 17.4% because \(\ln(1 + i) = 0.16\), where \(i\) is the percentage increase in question. Recall that the simple before-and-after method produces an estimated effect of 15.4%. The \(t\)-statistic for this net change is 1.33, which indicates statistical significance at the 91% level for a one-tail test. This test was performed by pooling the 1980 and 1990 data into one regression and, through the use of dummy variables, estimating the changes in the coefficients that occurred between 1980 and 1990. The full regression results thus provide some increase in the precision of the estimated effect compared with the simple before-and-after method shown above. In addition, the coefficients of distance (in miles) to the Midway Line right-of-way indicate a net change of 0.282. The \(t\)-statistic for this difference in coefficients is 1.78, which is statistically significant at the 96% level for a one-tail test. As expected, proximity to a station site adds to residential land values, while proximity to the Midway Line right-of-way reduces residential land values. The data are able to distinguish the benefits of proximity to a station and the nuisance of being close to the right-of-way. However, the statistical significance of the effect of proximity to a station site is only at the 91% level. Other regression results (not shown) demonstrate that the magnitude and statistical significance of the effect of proximity to the station site is unaffected by the omission from the regression equation of the variable distance to the right-of-way. One other study of residential land values in Chicago (McMillen and McDonald, 1993) was able to distinguish
these two effects of the elevated rail lines. Our interpretation is that the net effect of proximity to the station site on residential land values captures the benefits for households of improved transportation service.

For the record, the cross-section method would focus only on the regression results for 1990, which indicate an increase in land values near the stations of 12.1%. With a t-value of 1.34, this effect is statistically significant at the 91% level for a one-tail test. In this case the cross-section method underestimates the net effect of improved transportation service by some 5.3%.

Other specifications for the effect of proximity (within 0.5 miles) to the station sites on residential land values were used. One additional hypothesis is that the effect on land values is a function of distance to downtown because the amount of time saved depends on this distance. Regression results analogous to those shown in Table 3 yield the result that the estimated net effect is a 1.9% increase in land value per mile distance from downtown. The t-value for this net effect is 1.10, which indicates statistical significance only at the 86% level for a one-tail test. Nevertheless, this appears to be a reasonable estimate. An alternative specification uses land value (rather than the natural log of land value) as the dependent variable. In these results the estimated net effect of proximity to a station is $5.07 per mile of distance to downtown (in 1990 dollars). With a t-value of 1.08, this effect is statistically significant at the 86% level for a one-tail test. A standard lot is 25 feet wide, so this estimate translates into $126.75 per mile per lot. In another estimated regression with the natural log of land value as the dependent variable, distance to the station site was entered as a continuous variable. The net effect is estimated to be 0.189, or 20.8% per mile closer to the station. The statistical significance of this effect is 85% for a one-tail test (t = 1.02). The simulation results reported by Anas (1982) and the empirical results reported in Table 3 suggest that these effects are virtually identical to the ordinary least squares results discussed above.

Now consider the estimated increase in residential land values of 17.4%
arising from improved transportation service in light of the standard neoclassical theory of the urban housing market as discussed in Section 3. First of all, the increase of 17.4% three years prior to the opening of the transit line (with a real interest rate of 5%) translates into a 20.1% increase on opening day. Is this result consistent with the simulation results reported by Anas (1982)? Recall that the average increase in housing rents reported by Anas (1982) is 10%, so the increase in land values seems a bit low. Three possibilities exist.

First, it simply may be that the land market in 1990 had only adjusted partially to the Midway Line. This partial adjustment may be related to the factor of uncertainty discussed in Section 2. It may be that full adjustment will not occur until after the Midway Line is open and commuters know exactly the quality of the service that is being provided. However, in our judgment, the amount of uncertainty in 1990 concerning the Midway Line was not very great. The completion date had been announced, station sites were visible, the fares could be assumed to be equal to the fares on the other transit lines in Chicago, and the quality of the service could be estimated based on the performance of those other transit lines.

The second possibility is that a more complex relationship exists between the increases in housing rents and land values as indicated above in Eq. (6). It turns out that the assumption about the supply of capital can be very important; an increase in land value of 20.1% based on a housing rent increase of 10% is consistent with an elasticity of supply of capital of 1.68. Alternatively, a land value increase of 20.1% and a housing rent increase of 14.3% are consistent with an elasticity of supply of capital of only 0.66.

The third possibility is that a discrepancy is created by the fact that Anas (1982) assumed a longer Midway Line (by 3 miles) than was actually built. A simulation of the actual line using CATLAS could resolve this issue.

6. Conclusion

This study has examined the impact of the Midway Line on residential land values in 1990, three years prior to the opening of the transit line. The basic finding is that the urban land market had anticipated the opening of the Midway Line. Residential land values within one-half mile of the station sites were 17% higher than they otherwise would have been because of the future improvement in transportation service, and proximity to the right-of-way was regarded as a negative external effect. These impacts were found using a generalized before-and-after method that involves the estimation of land-value functions for 1980 and 1990. Alternatively, the estimated increase from improved transportation service was 1.9% (or $126.75 per lot) per mile
of distance to downtown Chicago for those sites within one-half mile of the stations.

The effect on residential land values of proximity to the stations of 17% (20% as of opening day) is less than one might expect given the simulation results on housing rents obtained for the project by Anas (1982, 1983) and given the value of the commuting time that is saved. Three possible explanations are offered for the seeming inconsistency. First, it may be that the land market had not fully adjusted to the Midway Line in 1990. Perhaps not enough information was available for the market to complete its adjustment to the new transit line. In any case, it is clear that the market had begun to adjust over three years prior to the opening of the line. Second, it is possible that the difference between the project simulated by Anas (1982, 1983) and the actual project explains part of the result. Anas assumed a project that is 3 miles longer than the actual Midway Line. Third, it may be that housing suppliers in the area of the Midway Line doubt that the supply curve of housing capital that is available to them is perfectly elastic. The impact of increases in housing rents on residential land values depends critically on the elasticity of supply of capital (or on zoning constraints that limit the ratio of capital to land). All three explanations are plausible, and further research will be needed to determine which is most important. The impact of the Midway Line on residential land values should be studied again after the line has been in operation for a period of time that is sufficient to permit the land market to adjust completely.

References


Hoyt, H. 1933, One hundred years of land values in Chicago (University of Chicago Press, Chicago, IL).


Thorsnes, P., 1994, Consistent estimates of the elasticity of substitution between land and non-land inputs in the production of housing, Department of Economics, University of Oregon, unpublished.