Tiebout Dynamics: Residential Neighborhood Adjustment to a Decline in the Quality of Local Public Services

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Abstract. A differential across a service-district boundary in the price of a standard house motivates a “supply” response. Henderson (1985) expects the activities of entrepreneurial home owners to reduce the price differential over time, while Ross and Yinger (1999) argue that constraints often prevent an effective response. We take advantage of an unusual “natural experiment” – a large 1920s subdivision of high-quality housing split neatly in half by a central-city/suburban boundary – to study the response over the last thirty years to a relative decline in the quality of central-city services that began in the 1960s. Sales data reveal the expected large house-price differential, which has not declined since it emerged about 1970. Census 2000 block data surprisingly show no difference in household demographic characteristics across the service-districts boundary. Survey data indicate that there has been a supply response: most children attend tuition-charging parochial schools or special public magnet schools, and a neighborhood association supplements municipal services. The central-city side of the subdivision appears to have become a small, informal Tiebout service district. The rigidity of the service-district boundary has prevented the closing of the house-price differential.
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1. Introduction

Tiebout (1956)-type models predict household sorting across a metropolitan area by preferences for the characteristics of local public goods and services. Household sorting is important because it promotes efficiency in the provision of local public goods. Specifically, it allows households to consume the public goods and services that match their preferences. And, it puts market pressure on service-district managers because home buyers bid up house prices in service districts that offer relatively attractive packages of public services and taxes. Service districts, therefore, behave essentially like monopolistically-competitive firms in which district home owners are the share holders.¹

A key characteristic of monopolistic competition is that profits in the long run trend toward zero. Short-run profits attract entrants and imitators in the long run. Analogously, Henderson (1985) expects high house prices in attractive service districts to elicit various supply responses: new districts, boundary shifts, changes in zoning and land use, and/or changes in public-service characteristics. These responses reduce or eliminate price differentials over time. Ross and Yinger (1999) argue, however, that a variety of constraints on adjustment allow price differentials in practice to persist for long time periods.

In this paper, we take advantage of an unusual “natural experiment” to look closely at the market response to a large house-price differential over a long and interesting time period. This quasi experiment takes place in an unusual 160-acre single-family subdivision developed in the 1920s in 583 building lots. The subdivision differs from its central-city neighbors in that it was innovatively designed and targeted to upper middle-income households; the quality of the houses and subdivision infrastructure is relatively high. More unusual is that the boundary between the central city (and its school district) and a suburb (and its school district) divides the subdivision neatly in half. The “natural experiment” arises due to the “flight” to suburban jurisdictions that began in the 1960s. The resulting central-city fiscal distress led to relative deterioration in central-city services quality, creating a mismatch on the central-city side of the

¹ Brueckner and Lee (1988) point out the parallels to the analysis of multi-product firms.
subdivision between house quality and public-services quality. Of interest is the long-term home-owner response to this mismatch.

We investigate this response using three types of data: house prices, census demographics, and the results of a household survey. Most existing empirical tests of Tiebout hypotheses analyze one of these three types of data. The results generally support Tiebout hypotheses, but are sometimes mixed, and are often prone to concerns about measurement bias.\(^2\) An advantage of the subdivision study is that all three types of data are available and are of relatively high quality. Another advantage is that the small geographic scale allows especially close attention to long-run adjustments and to the constraints on those adjustments. The disadvantage, of course, is that we cannot determine the extent to which our findings generalize. But a focused, small-area study can provide insights that inform larger-scale studies.\(^3\)

Consider house prices first. We sampled 100 subdivision houses of similar age and style, 50 on each side of the service-district boundary. This sample controls unusually well for house characteristics, accessibility, and local environmental characteristics. We collected the 359 arms-length sales of these houses that occurred from mid 1949 through 2002. The expected suburban-side price premium opens in the late 1960s and persists through the end of the century, which indicates unyielding constraints on supply adjustment. A close look at regulatory constraints reveals high hurdles to shifting the municipal and school-district boundaries to encompass the entire subdivision. Easing zoning restrictions appears easier, but zoning in the subdivision remains highly restrictive.

Next consider census demographics. We expect household demographics to reflect house prices and services quality. Census tracts follow municipal boundaries, so each half of the subdivision is part of a different census tract. While similar in 1960, census-tract demographic characteristics in year 2000 differ as expected across the service districts boundary. Looking more closely at block-level data shows, however, little difference in demographics across the boundary within the subdivision. Demographic

\(^2\) We describe the relevant literature later in the paper.

\(^3\) The approach we take is similar to the “case-control” approach frequently used in epidemiological studies. It is inferior to the “gold standard” of the double blind randomized control trial. But epidemiologists face situations, as is common in economics, in which a proper randomized control study cannot practically be implemented. For example, randomly selecting people to smoke or not smoke for thirty years is an impractical way to study the effects of smoking on long-term health. The results of case-control studies are often used to inform larger-scale studies.
characteristics (and zoning) appear to vary with house quality rather than with public-services quality, and tract-level data obscure those differences.

Finally, we spoke with neighborhood representatives and surveyed 200 subdivision households, 100 on each side of the public-services boundary. A neighborhood association active only in the central-city side of the subdivision supplements municipal services. Crime rates and the quality of neighborhood infrastructure and environment are similar to those on the suburban side of the subdivision. The survey, to which 70% of households responded, reveals Tiebout sorting. In particular, central-city side households expressed disinterest in the characteristics of the suburban-side public schools, preferring to send their children to nearby tuition-charging parochial schools or to central-city “magnet” schools.

In sum, our admittedly small-scale study reveals novel insights into Tiebout dynamics. We find evidence of Henderson’s “supply response” in the form of an active neighborhood association and nearby parochial schools and special public magnet schools. This supply response corresponds with Tiebout sorting: the high-quality housing on the central-city side attracts households who are demographically similar to their suburban counterparts, but who are relatively uninterested in the characteristics of suburban public schools. Consistent with Ross and Yinger, the rigidity of the service districts boundary apparently prevents reduction in the house-price differential. Ironically, the rigidity of the boundary appears to improve efficiency because it increases the range of housing and local public goods over which metro-area households can choose. This localized sorting is, however, hard to detect; Tiebout sorting can occur across the neighborhoods within formal service districts or even within census tracts.

The remainder of the paper is organized as follows. Section 2 describes the estimation of the time trends in house prices on each side of the service-districts boundary. Section 3 discusses constraints on supply adjustment, and describes the demographic and home-owner response to the boundary effect. Section 4 concludes the paper.

2. Estimates of the trends in house prices

In this section we describe the estimation of the trends in the price of a house with a standard set of observed characteristics on each side of the subdivision from 1949 through 2002. The analysis adds to a
list of recent papers that treat the problem common in capitalization studies of missing or poorly measured variables. Inaccurate measures of public-services quality and inaccurately measured or missing house and neighborhood characteristics potentially bias estimates of the capitalization of differences in service quality into house prices. Ross and Yinger, in their 1999 survey article, report that while easily-measured differences in local taxes are consistently found to capitalize into house-prices, capitalization of differences in public-services quality has been inconsistently detected. In contrast, recent studies that take advantage of relatively good measures of public-school quality and that control relatively well for differences in house quality, e.g., Black (1999), Bogart and Cromwell (2000), Weimer and Wolkoff (2001), Downes and Zabel (2002), Kane, Staiger and Reigg (2005), and Reback (2005), provide consistent support for the capitalization of even modest differences in public school quality.

House-price data from the case-study subdivision offer another opportunity to control for difficult-to-measure variables. The subdivision data allow especially good control over house and neighborhood characteristics. All of the houses in the data set are within a half mile of each other, so there is little variation in general accessibility or environmental conditions. And all of the houses are of similar style and vintage, and were subject to minimum construction-expenditure requirements. There is probably relatively little variation in construction quality. We cannot measure the quality of public services directly. Rather, we take advantage of the relative decline in the quality of the package of central-city municipal and school-district services that resulted from the central-city fiscal distress caused by the flight to suburban jurisdictions that began in the 1960s. We expect to see little difference across the public-services boundary in the price of a standard house prior to the 1960s because the central city was able to annex most developing areas; developers apparently found the quality of central-city services generally acceptable. Whether or not there was any prior difference in house prices, any subsequent change in the boundary-price differential reflects the relative decline in the quality of central-city services.

The sales data

The subdivision, named Ottawa Hills, was platted in three phases in 1922, 1923, and 1924 in the urban fringe of Grand Rapids, Michigan. The location of the subdivision is shown in Figure 1, which also
shows the territorial expansion over time of the central city of Grand Rapids. The western half of the subdivision is in the central city, which annexed the area in 1891. The eastern half of the subdivision is in the City of East Grand Rapids (EGR), which was first incorporated as a Village, also in 1891, to provide services to a lakeside summer recreation area. The Village became a city in 1926 in response to the expansion from the west of Grand Rapids residential development toward the Village. The central city continued to expand around East Grand Rapids until the early 1960s, at which time it essentially stopped annexing new territory. While the population of the central city has experienced little gain since 1960, then and now about 190,000, the population of the Grand Rapids urbanized area (central city plus suburbs) grew from about 350,000 persons in 1970 to about 540,000 in 2000. Nearly all of the new residential development since the 1960s has occurred in suburban jurisdictions.

Figure 2 shows the layout of the building lots in the subdivision and the location of the public-services boundary. The subdivision occupies a square area roughly one-half mile on a side, or roughly one-quarter square mile in area. The parcel was originally developed as a golf course, and the layout of the fairways influenced the novel street design. The original configuration contained 583 lots. Purchases of multiple lots and numerous lot-line adjustments over time resulted in a current total of 456 building lots in the subdivision, eight of which are not built on (these are typically used as yards). The current characteristics of every house and lot in the subdivision were collected from the Grand Rapids and East Grand Rapids tax assessors’ offices, and are summarized in Table 1.

A key characteristic is the year of house construction. The median year built is 1927 on the Grand Rapids side, and 1939 on the East Grand Rapids side. Figure 3 shows the distribution of houses built by year on each side of the subdivision. The houses on the Grand Rapids side are on average older, smaller, and on smaller lots than those on the East Grand Rapids side. Part of the reason for the slower

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4 The lake is about a mile to the northeast of the subdivision.
5 There were two small annexations to the central city in the 1990s to the north of East Grand Rapids. These are large commercial developments that the central city was better prepared to serve than was the mostly residential suburban jurisdiction.
6 This pattern appears to be typical. Mieszkowski and Mills (1993) report that about 57% of metropolitan-area population lived in central cities as recently as 1950. That proportion fell to about 37% by 1990.
7 In Michigan, each city or township conducts its own assessment of property value for the purpose of taxation. A county “equalization” office monitors the local jurisdiction’s performance.
development in the suburban side is that the recently chartered City of East Grand Rapids was still organizing its public-service delivery systems in the 1920s. Important for this study, however, is that the older houses that are on the suburban side – those most comparable to the houses on the central-city side – are concentrated in the northern part of the subdivision, the area north of Alexander Rd. A likely contributor to this north-to-south development pattern was the presence of a sewerage settling pond in the 1920s and 30s to the southeast of the subdivision.

We collected sales data on a sample of fifty houses of similar age and style from the northern half of each side of the subdivision, one hundred houses in total. All of the houses in the sample were built between 1924 and 1935, have two-stories, at least three bedrooms, brick veneer, and significant amounts of ornamental trim. There are a total of fifty-two houses of this style and age in the northern half of the suburban side of the subdivision (i.e., north of Alexander Rd.), two of which are on a relatively busy street that borders the subdivision. We use the remaining fifty houses as our suburban sample. We chose a sample of fifty houses randomly from the larger population of houses of similar age, style, and location away from the border streets in the northern part of the central-city side of the subdivision.

The current observable characteristics of the sample are summarized in Table 2. Note that the range in these characteristics is similar on each side of the subdivision, though the houses and lots on the suburban side are somewhat larger on average than their counterparts on the central-city side. While there is considerable variation in the size of the houses in the sample, the variation in house and neighborhood characteristics that are unmeasured – accessibility to urban centers, construction quality, and neighborhood environmental quality – is unusually small, and not correlated with the public-services boundary. Only public-services quality and taxes vary across the boundary.

An issue is the extent to which the characteristics of the houses changed over the time period. The assessors’ offices maintain a folder for each property in the jurisdiction. Each folder contains an annotated history, back to 1950, of the assessed values of the house and lot. The annotations include dates and characteristics of most additions and of some renovations. The dates of the additions are noted

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8 The developers placed restrictions on the sale of each building lot that specified, among other things, the minimum allowable expenditure on the structure, usually $8000 to $10,000.
if a building permit was obtained. Otherwise, the date that the assessor’s staff "discovered" the addition, presumably in the course of a periodic survey, is reported. Thus, the photos and the records maintained by the assessors’ offices provide reasonably accurate data about the additions to floor space since 1950. There are, however, house characteristics, including current condition and interior updates and renovations, that are omitted or only crudely measured by the assessor.

We collected the price and date of each sale of each house in the sample since mid-1949. The information is recorded on the deed of sale, which is kept on file at the county offices. Until the 1990s, the sale price did not have to be recorded on the documents available to the public, and the standard practice was to record the transaction price as “one dollar and other valuable considerations”. However, the sale price can reliably be calculated from the value of stamps affixed to the deed that verify payment of the state real estate transfer tax. We identified a total of 359 usable arms-length sales over the 53-year time period, 189 of which are in East Grand Rapids and 170 in Grand Rapids.

The number of times a house sold over the time period varies. Two houses on each side of the boundary did not sell over the period. Roughly half of the houses sold three times or more, while the maximum number of sales of any single house was seven. We rejected sales as not arms length that involved buyers and sellers with the same surname. We also observed that on occasion a house sold twice within a short period of time (less than two years), with the later sale at a significantly higher price than the earlier one. We were advised that a house in relatively poor condition is sometimes purchased by someone who renovates it, then resells it. Consistent with Clapp and Giaccotto (1999), we used only the later of these sales. We regressed the number of times a house sold on the observed characteristics of the house and found no significant relationships. The variation in the number of sales is either random or correlated with unobserved variables. The fact that the largest number of sales is seven – an average of

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9 The year 1949 is the cut-off because sampling indicates that the effects of the Depression on property sales affected the market through the early 1940s. The cost of additional data collection seemed to outweigh the benefit.

10 We collected most of the information from copies of the deeds kept on file in the Grand Rapids office of TransNation Title Insurance Company. These copies are considerably easier to retrieve than those on file at the County. We thank Monte Reinert, Eileen Mueller, and members of their staff for invaluable assistance in collecting and interpreting the sale prices analyzed in this study.
7.5 years between sales – suggests that none of the houses have unobserved characteristics that induce especially rapid turnover.

There are an average of 6.65 sales per year, with a standard deviation of 2.85 sales. Figure 4 plots sales per year, which shows little trend over this long time period: the estimated coefficient on year of sale in a regression of sales per year on year of sale is positive, but small, 0.02, and statistically insignificant (the standard error is 0.025). An exception is the recession of the early 1980s; only seven houses sold in the years 1980 through 1984. That recession had an especially strong impact on the interest-rate sensitive manufacturing economy in Michigan.

Figure 5 plots sale price per square foot of floor space over the 53-year time period. The plot indicates only a slow increase in prices over the first twenty years of the period. Importantly, sale prices appear similar on both sides of the boundary until the late 1960s, consistent with the hypothesis of a unified neighborhood prior to the flight to the suburbs. Sale prices diverge after about 1970 as expected given the relative decline in central-city services quality with the fiscal effects of suburban flight.

Estimation procedure and results

The sale-price scatter in Figure 5 controls only for differences in house size. We extend this analysis in two steps. First, to get a feel for the time path of prices, we estimate a subdivision house-price index for each side of the boundary. We then estimate the time trend in the boundary-price differential directly to test if and when house prices differ statistically.

We use standard hedonic techniques. A general hedonic house-price function can be expressed as:

\[ \ln P = f(H, A, S, \epsilon) \]  

where \( \ln P \) is the natural log of the sale price of the house, \( H \) is the quantity of housing services supplied by the house and lot, \( A \) represents accessibility or the cost of transportation to urban centers, \( S \) represents the quality of public services, neighborhood amenities, and taxes, and \( \epsilon \) captures the randomness in price formation. Accessibility does not vary across our sample of houses. We proxy housing services, \( H \), by a vector of observable house characteristics. Public services and taxes vary only with the municipal/school-district boundary.
The price index on each side of the service-district boundary can be estimated using a standard specification:

\[ \ln P = X \beta + f(t) + g(t) + \varepsilon \]  \hspace{1cm} (2)

where \( X \) is a vector of observed house characteristics, \( f(t) \) is the time trend in the price of a standard house in one service district, and \( g(t) \) is the corresponding price index in the other service district. This specification involves several assumptions. First, the coefficient vector \( \beta \), which shows the market values of marginal changes in observed house characteristics, does not vary across the public-services boundary. The rationale is that arbitrage equalizes the marginal value of those characteristics, such as floor space and number of bathrooms, that can relatively easily be adjusted and the costs of making those adjustments, i.e., the prices of labor and materials, do not vary across this small area. Second, the \( \beta \)s do not vary over time. The rationale is that while improvements in technology over time reduce the unit cost of building materials, the relative costs of various improvements remain essentially unchanged. Finally, the observed characteristics in the vector \( X \) effectively control for house characteristics. The houses in the sample were chosen to minimize the variation in difficult-to-measure characteristics.

A key issue is how to specify \( f \) and \( g \) in (2). A critical characteristic of the estimator is flexibility as theory offers no guidance on the form of the trend in prices over time. There are a variety of flexible procedures, each with its advantages and disadvantages: time dummies, a high-order polynomial in time, local linear regression, kernel regression, cubic splines, and the flexible Fourier form. Time dummies are especially undesirable in this context because the number of observations in any relatively short time period, such as a year, is small. We chose to use the flexible Fourier expansion because it is flexible, efficient, and easy to implement. Pagan and Ullah (1999) describe the general procedure and McMillen and Dombrow (2001) apply it to the estimation of house-price indices.

The Fourier expansion derives its flexibility from the use of sine and cosine wave functions of varying frequencies. Following McMillen and Dombrow, the time trend \( f(t) \) can specified as:

\[ f(t) = \alpha_1 z + \alpha_2 z^2 + \sum_{q=1}^{Q} (\lambda_q \sin(qz) + \gamma_q \cos(qz)) \]  \hspace{1cm} (3)
where \( z = \frac{2\pi}{\max(t)} \), which transforms the sale date, \( t \), to lie between 0 and \( 2\pi \). \( z^2 = \frac{2\pi^2}{\max(t)} \), and \( Q \) defines the number of terms in the expansion. As a practical matter, the number of terms usually need not be large, with \( Q \) equal to 1 or 2, when the form is applied to only one regressor. Substituting (3) and a similar expression for \( g \) into (2) allows estimation of the hedonic price function by OLS. The estimated coefficients can be used to calculate the price index at any series of target times.

The estimates of the coefficients on the house and lot characteristics in equation (2), using the Fourier form with \( Q \) equal to 2, are reported in the first column of results in Table 3. The data include all 359 observations on sample sales from 1949 through 2002. The dependent variable is the natural log of sale price. The estimated coefficients on the variables that measure house characteristics for the most part appear reasonable. An additional 100 square feet of floor space increases sale prices by about 1.5%, while an additional 1000 square feet of lot space increases sale prices by about 2.8%. An additional bath increases sale prices by about 9%. That the age of the house at the time of sale has no effect supports our assumption that the houses built from the mid 1920s through the mid 1930s are of similar construction quality. It is a bit surprising that additional garage space has no effect. The coefficients on the terms in the Fourier time trend are not reported in the table because they individually do not offer a straightforward interpretation. The regression explains about 95% of the variation in houses prices, much of which is explained by the time trends.

Figure 6 plots the estimated time trends for a house with characteristics that correspond to the means in the 100-house sample over a scatter of the natural log of sale prices. The estimated trends again show modest price appreciation through most of the 1960s, and importantly, there appears to be little difference in house prices during that time period across the central-city/suburban boundary. As expected a price differential opens in the late 1960s as prices in the suburb begin rising while central-city prices continue their previous flat trend until about 1973. The price differential persists through the end of the study.

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11 In this case we observe the date of sale. So the variable \( t \), which measures the number of years since the beginning of 1949, is essentially continuous and takes a value from 0 to 53. The term \( \max(t) \) is simply 53.

12 The estimated time trends and coefficients on house characteristics are substantially unchanged using alternative flexible estimators for the time trend, such as a high-order polynomial in time.
period. Though there is a hint that the differential is closing toward the very end of the time period, flexible estimators tend to be unreliable at the “edges” of the data.\textsuperscript{13}

We test the early-period equivalence of prices across the boundary using a less efficient, but intuitively appealing, estimator. We define (arbitrarily) a ten-year window beginning in January 1949, and estimate (2) assuming that $g(t) = f(t) + \text{constant}$. That is, we simply include a dummy equal to one if the house is in the suburb (i.e., in EGR). We then slide the earlier end of this ten-year window through time at one-quarter year intervals from 1949 through the third quarter of 1992. This exercise produces 175 quarterly estimates of the ten-year average boundary effect (the coefficient on the EGR dummy) and its standard error over the 53-year time period.

Figure 7 plots over time the estimated boundary effect and its 95% confidence interval. Each quarterly estimate of the price differential is plotted at the mid-point of the ten-year window, i.e., the results from the first regression, 1949 through 1959, are plotted at 1954. Consistent with the Fourier estimates, the estimated boundary effect is close to zero and statistically insignificant in the 1950s through the mid 1960s. There is no significant difference in house prices across the boundary in any ten-year period prior to that centered on 1967. The boundary effect becomes significant in the late 1960s,\textsuperscript{14} and, though things get messy during the recessionary early 1980s, does not appear to shrink on average throughout the remaining thirty years covered by the data.\textsuperscript{15} Indeed, the boundary effect exceeds 40% of central-city side prices in the 1990s.

We can check that our 100-house sample is representative by comparing the sample results to the results from the population of subdivision sales since 1991. The assessors in each jurisdiction have readily-accessible records of all house sales, 372 in total, in each side of the subdivision since the beginning of 1991. We estimate a simple linear trend in the boundary price differential by including a suburb dummy and the suburb dummy interacted with time of sale. The results are shown in the middle

\textsuperscript{13} Increasing $Q$ to 3, i.e., adding higher-frequency sine and cosine terms, increases considerably the flexibility in the estimated time trend. The general trend in the boundary differential is similar, but the trend line appears more sensitive to individual observations among the relatively few observations in a given year.

\textsuperscript{14} The small number of sales per year do not allow an accurate estimate of the year in which house prices began to diverge. However, it does not appear that an accurate estimate is needed in the current context.

\textsuperscript{15} The series of regression results shows no trend in the coefficient on any of the house characteristics, though the coefficient estimates cycle, suggesting the effect of influential observations in the relatively small sub-samples.
and right-hand columns of results in Table 3. The point estimate on the suburb dummy (the boundary effect in 1991) is large and highly significant in both samples, and the dummy interaction (the trend in the boundary effect since 1991) is small and insignificant. That the results are similar indicates that the 100-house sample is representative.

That the estimated coefficient on the EGR dummy is larger using the full population of sales supports concerns about bias from unobserved heterogeneity in house characteristics. Eliminating the dummy interaction term in the regression reduces the estimates of the coefficients on the EGR dummies to 0.345 in the 100-house sample and 0.386 in the full population of sales. The houses in the full population of sales on the EGR side, especially those in the southern half of the subdivision, tend to be newer, larger, and of more varying style than those on the central-city side. The resulting unobserved differences in house characteristics probably bias upward the estimate of the boundary effect from the full population of sales.

These results indicate that by the late 1990s the boundary differential was about 41% of the price of a standard house in the central-city side of the subdivision.\textsuperscript{16} This represents a differential of about $100,000 on the median sample house in year 2000. There are three potential sources of this differential: higher local taxes, poorer (unobserved) house condition, and/or lower quality neighborhood amenities and public services on the central-city side of the subdivision.

The local taxes on the central city side appear to be lower, rather than higher, than suburban-side taxes. The property tax rate on the central-city side of the subdivision is about half that on the suburban side: currently about $22 per thousand dollars of taxable value versus $44 on the suburban side.\textsuperscript{17} But the central-city imposes a tax on income of 1.3%, while there is no suburban income tax. We can easily get a feel for the relative sizes of these taxes. Assuming, optimistically, that household income on the central-city side of the subdivision equals the median suburban-side income of $85,000 in year 2000, the income

\textsuperscript{16} \textit{Exp (0.345)} – 1 = 0.412, or about 41%.

\textsuperscript{17} When a house sells in Michigan its taxable value is set equal to its assessed value, which is half of market value. Between sales, taxable value falls over time as a proportion of assessed and market value due to a regulatory ceiling on taxable-value inflation.
The difference in the property tax payment on the median central-city side house, worth about $250,000, is roughly $2750 (taxable value equals half of market value, thus $44 - $22 times 125,000 equals $2750). The difference in the property-tax across the boundary almost certainly exceeds the income tax, so local taxes are lower in the central-city side of the subdivision.

We lack the data to control for systematic differences across the boundary in house condition. Indeed, one might expect that the lower sale prices on central-city houses since the late 1960s encourage lower expenditure on maintenance and improvements. Part of the price differential probably reflects unobserved differences in current house condition. But it seems sensible to include any effects on house condition as part of the total effect of the difference in public services and taxes. Thus, while the estimate of the boundary differential may be a biased estimator of the effect of the difference in public services and taxes on the price of a strictly standard house, it can reasonably be considered an unbiased estimator of the total effect on house values, which includes any effect on house condition. 19

These arguments suggest that the price differential can be interpreted as a lower-bound on the value of the differences between central-city and suburban public-services quality. 20 That is, we appear to have detected significant public-services capitalization. The evidence presented in the next section, however, casts doubt on this conclusion.

3. Response to the house-price differential

The disparity in service quality clearly reflects the general disparity in household incomes between central city and suburban jurisdictions. Mieszkowski and Mills (1993) discuss two classes of theories that explain this income disparity. The “natural evolution” story explains the suburbanization of higher-income households: given improvements in transportation infrastructure, middle and higher-income households are more willing to trade off short commutes for the lower congestion, higher environmental quality, and newer and better houses in suburban areas. Of interest is that the City of Grand Rapids until

18 Income is not available at the block level from census statistics.
20 The differential is only a lower bound because capitalization of the lower central-city taxes reduces the differential.
the early 1960s was able to annex and extend services to these developing suburban areas. The “flight-from-blight” theory motivates the formation of separate suburban jurisdictions: the older, smaller, and more crowded housing in the central city filters to lower-income households, who cannot afford to support the relatively high-quality urban public services, especially educational services, that the growing number of middle-income households demand. Why the 1960s is the watershed in Grand Rapids is not obvious, though the construction of urban freeways and racial tensions played roles.

Though probably common at central-city boundaries, it is still somewhat surprising that such a large price differential has persisted for so long among the otherwise similar houses in the case-study subdivision. We would expect to see a supply response to the price differential. Henderson (1985) argues that a supply response is likely because entrepreneurial land owners and developers can respond in a variety of ways: they can (1) pressure district officials to adjust district boundaries, (2) alter the characteristics of existing development, or (3) change the characteristics of public services. In some Tiebout-type models, such as Hamilton (1975) and Henderson (1991), these long-run adjustments eliminate house-price differentials: households sort by preference for public services, but the price of a standard house does not in long-run equilibrium vary across service districts. Ross and Yinger (1999) argue in their review article that practical constraints inhibit supply adjustment, and observe that most Tiebout-type models correspondingly include assumptions such as a fixed number of jurisdictions and inflexible boundaries. That the price differential across the subdivision has persisted for more than thirty years indicates such binding constraints. In this section we first describe the constraints on supply adjustment, and then report the results of a household survey to better understand supply adjustment or its absence.

Supply adjustments and the constraints on adjustment

An obvious home-owner response to the large house-price differential is to organize a shift in the public-services boundary to bring the central-city half of the subdivision into the suburb. This “de-annexation” from the central city, which would be relatively small at eighty acres, would reunite what

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21 The expansion in some directions was constrained by pre-existing municipalities, such as East Grand Rapids.
appears to have been a cohesive neighborhood.\(^{22}\) State law in Michigan, however, requires a city-wide vote on any proposed de-annexation from a city.\(^{23}\) One would expect such a vote to go against the de-annexation because the property-tax payments from houses in the central-city side of the Ottawa Hills subdivision average more than twice the central-city average; the boundary adjustment would have a disproportionately large impact on central-city finances.\(^{24}\) This case is apparently similar to that in Ohio described by Garasky and Haurin (1997) in which an attempted de-annexation failed, but the voting margin was smaller than expected because voters in precincts close to the city boundary tended to support the de-annexation. City officials inform us that there have been no attempts to de-annex the western half of the Ottawa Hills subdivision.

Shifting the school-district boundary does not, in contrast, require a city or district-wide vote. And it may be that the difference in the quality of the public schools explains a relatively large portion of the price differential. Output measures, such as test scores and graduation rates, indicate that the public schools in the suburb are of considerably higher quality than the central-city schools that serve the Ottawa Hills neighborhood. School district and city boundaries do not generally coincide, so a shift in the school district boundary would not be anomalous. Two-thirds of the households in Grand Rapids’ Ottawa Hills neighborhood could initiate the process of de-annexation by filing a petition with the county Intermediate Service District (ISD), a public agency that supplies various services to the school districts in the county. The ISD then works with the two school district boards to resolve the petition.

At least two practical considerations appear to work against the school district de-annexation. First, a Grand Rapids school district building is located in the subdivision, in the large area labeled ‘477’ in Figure 2. East Grand Rapids has already a surplus of school space due to the general reduction in the number of children per household, so would likely welcome the additional children from the de-

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\(^{22}\) Henderson (1985) reports about 1.4% as many de-annexations as annexations nationwide between 1950 and 1976. Epple and Romer (1989) similarly find about 1.7% as many de-annexations as annexations between 1970 and 1979, where the average de-annexation is small at 285 acres. These de-annexations arguably represent the marginal adjustments to service-district boundaries that dissipate rent differentials.

\(^{23}\) Procedures for municipal boundary adjustments are described in *Local Government Law and Practice in Michigan*, J. J. Rae, editor, published in 1999 by the Michigan Municipal League.

\(^{24}\) The prices of the approximately 13,000 sales of houses in the central city from 2000 through 2002 averaged about $110,000, compared with an average of $259,000 for the nine sales in the central-city side of the Ottawa Hills subdivision.
annexation, but would likely prefer not to purchase and maintain the building. Second, in addition to paying the higher property taxes that come with higher house values, residents on the central-city side of the neighborhood would have to continue to contribute toward the service of Grand Rapids school district debt. Home owners would see more than a doubling of their property taxes. And, because they would remain in the central city, they would continue to pay central-city income tax. To date, no petition has been filed with the ISD.

Prevented (or discouraged) from de-annexing, entrepreneurial owners of homes on the Grand Rapids side of the subdivision might try to alter the characteristics of development. Demolition and redevelopment of the area seems an undesirable option because the housing stock in the neighborhood is historic, of high construction quality, and difficult to duplicate in the suburbs. A more plausible option would be to ease zoning restrictions from the current single-family residential zoning to allow multi-unit residential and/or commercial uses in existing structures. The current zoning in the central-city areas to the immediate north, west, and south of the subdivision is less restrictive, allowing multi-family use. This suggests that a relaxation of zoning should be relatively easy to accomplish.

A look at the history of zoning in the area is instructive. Until 1951, zoning in the subdivision (and its nearby environs) was less restrictive than the current single-family zone, allowing one and two-family dwellings, churches, schools (hence the school located in the subdivision), libraries, and even “farming and truck gardening”. The case-study subdivision, and only this subdivision, was up-zoned to single-family residential in 1951, and so it remains (since 1969 in the “R-1” zone). The neighborhoods around the subdivision were also up-zoned to residential, but the zone, currently known as “R-2”, allows smaller building lots (4000 versus 7200 square feet) and two-family dwellings. Lot sizes are smaller in these neighborhoods. Interestingly, the area immediately to the north of the subdivision was rezoned R-1A in 1988, which is less restrictive than R-1, but more restrictive than R-2. Area residents felt that the variances being allowed under the R-2 zone were leading to degradation in the quality of the neighborhood. Thus while zoning is probably more flexible than are service-district boundaries, there

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25 East Grand Rapids closed one of four elementary schools in the district and allows entry to the district through a lottery to fill remaining seats.

26 With one exception: two-family dwellings are allowed on corner lots that front on a major street.
appear to be limits to this flexibility in this primarily residential area. Nevertheless, the central-city side of the subdivision remains an island of relatively restrictive single-family zoning.

No boundary adjustment and no alteration in the characteristics of development leave as a supply response only adjustment in the characteristics of the local public goods and services consumed by the households in the neighborhood. We found that an active neighborhood association operates in the central-city side of the subdivision. There is no formal association operating in the suburban side of the subdivision nor in the central-city neighborhoods that border the subdivision. The association’s budget consists mainly of householders’ time rather than revenue from fees or dues. Key activities supplement municipal services. The association organizes home owner efforts to maintain neighborhood security, lobbies for prompt and quality delivery of city services, and organizes neighborhood clean-ups and an annual neighborhood party. Crime rates in the case-study neighborhood are far below the central-city average, and are comparable to those on the suburban side of the subdivision. Neighborhood infrastructure and aesthetics are also comparable to those in the suburban side. Thus the activities of the association appear to close much of the gap in the quality of several key municipal goods and services.

Perhaps the most highly-valued public service is K through 12 schooling. Access to relatively high-quality, tuition-charging schools in the area is good. There are seven parochial elementary schools and two parochial high schools within a few miles of the subdivision. This raises the possibility that the quality of the services actually consumed by subdivision residents varies significantly less across the service-district boundary than that indicated by municipal and public-school performance measures.

A plausible hypothesis is that the high-quality houses and neighborhood on the central-city side attract households who demand services of similarly high quality. The neighborhood association and the nearby private suppliers of educational services meet this demand. The persistent house-price differential under this hypothesis in part compensates for the additional cost of the privately-supplied services, rather

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27 There are neighborhood associations active in several other central-city neighborhoods, but no formal neighborhood associations are active in any of the East Grand Rapids neighborhoods.

28 The association, for example, convinced the City to install ornamental street lighting different from (and more expensive than) the standard street lights used in neighboring areas.
than for the low quality of central-city services.\textsuperscript{29} That the nearby private schools are parochial schools may provide an especially strong indicator of Tiebout sorting: the households on the central-city side prefer suburban-quality housing and a key service characteristic, religiously-based education, that suburban public school districts cannot legally supply.\textsuperscript{30}

\textit{Tiebout models predict sorting by preferences for local public goods and services, but preferences are difficult to observe. Using demographic characteristics as proxies for preferences has produced mixed results. Using a cross-section of 1990 Census demographic data, Heikkila (1996), for example, finds that municipal boundaries correspond with clusters of demographically-similar census tracts, consistent with Tiebout sorting. Rhode and Strumpf (2003), in contrast, find that the heterogeneity in census demographics across municipalities has surprisingly decreased over the last 150 years. Reductions in transportation costs over this long time period should have facilitated sorting. Studies that take advantage of more direct measures of preferences, such as surveys, e.g., Gramlich and Rubinfeld (1982), or actual intra-metropolitan relocations, e.g., Hanushek, Kain, and Rivken (2004), consistently provide evidence of Tiebout sorting. We analyze both demographic and survey data.}

Table 4 summarizes subdivision demographic characteristics on each side of the service-district boundary. The four columns on the left-hand side of the table show data for the subdivision obtained from Census 2000 block data. The four columns on the right-hand side of the table show corresponding data for the \textit{remainder} of the census tract occupied by each side of the subdivision (the census tract boundary coincides with the service-district boundary because census tracts aggregate to

\textsuperscript{29} The four Catholic elementary schools in the area currently charge about $2600 per year for one student, one of the Protestant elementary schools charges about $3200, and the other two about $5200. Quantity discounts apply for additional children from the same family, and actual fees vary with ability to pay at the higher-priced schools. We lack a good estimate of the actual average fees paid at the elementary level. Fees at the Catholic high school are about $5000 per student, and at the Protestant high school about $6200.

\textsuperscript{30} Of the 61 non-public, tuition-charging schools that provide K-12 education in Kent County (the county that houses most of the Grand Rapids urbanized area), fifty-nine are parochial schools. Approximately 16\% of school-age children attend one of these 61 private schools, 97.5\% of whom attend a parochial school.
The demographic characteristics within the subdivision are surprisingly similar across the boundary given the differences in both house prices and the quality of municipal and school district services. Only the proportion of the population that is African-American differs: 12% on the central-city side relative to 1.2% on the suburban side. These block-level data do not provide demographic support for Tiebout sorting.

The demographic characteristics of the rest of the central-city census tract differ starkly from those in the suburb and from those in the central-city side of the subdivision. Not surprisingly, median household income in the central-city census tract is less than half that in the suburban census tract. Thus the relatively high-quality housing on the central-city side of the subdivision appears to attract households demographically much more like their suburban counterparts than like their central-city neighbors. Importantly, the demographic characteristics of the households in the central-city side of the subdivision differ starkly from census tract averages.

We test our hypothesis of differences in preferences for school characteristics with a simple survey. The objective of the survey is to investigate whether location affects school choice, and whether prior preference for private versus public school affects the choice of location. We ask (1) when the household moved to the neighborhood (as opposed to their current house), (2) whether they have, have had, or plan to have school-age children and when the children attended school, (3) whether their children attend private (tuition-charging) school, public school, or a mix, (4) whether their preference for private versus public schooling influenced their decision to locate in the neighborhood, and (5) what the key factors were that determined their location decision (an open-ended question).

We sent this short survey, with return postage paid to the owner-occupiers of 200 houses in the northern half of the subdivision, 100 on each side of the public-services boundary. We started with the owners of the houses in our original 100-house sample (described in the previous section) who assessors’ records show occupy their house, plus an additional sample of owner-occupiers chosen randomly from

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31 The central-city side of the subdivision occupies the southeast quarter of census tract 33 in the City of Grand Rapids, and the suburban side of the subdivision occupies the southwest sixth (or so) of census tract 124 in the City of East Grand Rapids.

32 Median household income is not reported at the block level, so we cannot compare household incomes across the boundary within the subdivision.
the northern half of the subdivision. We received 121 completed surveys via return mail and completed 19 more through follow-up phone calls for a total of 140 completed surveys (70%), 72 from the central-city side and 68 from the suburban side of the subdivision.

The results, which are shown in Table 5, indicate clear differences across the school-district boundary in the choice of schools. On the suburban side, of the 63 households with children, 48 (76%) sent them exclusively to the local public school. Of the ten households whose children attended a mix of schools, six sent them to private school less than a quarter of the time, and three sent their children to private elementary school and then to public high school. Thus, over 90% of the suburban respondent households sent their children at least half of the time to the local public schools.

As expected, a solid majority of the 62 central-city side households with children sent them all or most of the time to private schools. Still, it is a bit of a surprise that 40% sent their children to public schools most of the time. Some of these children attended public schools before the relative decline in school quality: 8 of 25 attended in the 1950s or 1960s, and another 8 attended in the 1970s. Excluding these households as irrelevant increases to 80% the proportion of households sending their children mostly to private schools. Importantly, some of those who more recently sent their children to central-city public schools indicated that they sent them to central-city public magnet schools, rather than to the neighborhood public schools.

Magnet schools represent a public supply response to the demand for relatively high-quality educational services. Magnet schools restrict enrollment to relatively capable students. The magnet schools are an effort by the central-city public school district both to accommodate diversity in the abilities and needs of children and to increase the range of public school characteristics offered within the district. The City magnet high school is particularly well regarded. Both the private schools and the magnet schools supply educational services of a quality higher than the central-city norm. It appears that the households on the central-city side of the neighborhood are supplied with services of a quality

33 To avoid discouraging a response we did not ask respondents to tell us the name of the private school to which they sent their children. We did, however, leave room for comments. Of the 47 respondents on the central-city side whose children attended private school at least part of the time, 16 volunteered the name of the school(s): consistent with the overall preponderance of tuition-charging schools that are parochial schools, 15 of these 16 sent their children to parochial school.
commensurate with house and neighborhood quality. Most of the households with children choose parochial schools, others choose the public magnet schools.

Of interest is the homogeneity of the stated preferences for those services. On the suburban side fully 81% of respondents indicated that the quality of the suburban public schools was a primary determinant of their decision to locate in the suburb. Respondents generally were attracted by the quality of houses, schools, and municipal services in the suburb. This is consistent with Tiebout sorting. In contrast, only just over half of the 37 respondent central-city side households who sent their children mostly to private schools were attracted by the proximity to those schools. Indeed, over 40% of the households with children, wherever they sent them, reported that they moved to the neighborhood without consideration of schools (compared with 6% on the suburban side). This lack of homogeneity in preferences appears inconsistent with Tiebout sorting.

There is, however, a rationale for discounting this conclusion. Almost all of the central-city side households reported that the low costs associated with the high quality houses and neighborhood amenities were the primary attraction of the neighborhood. Neighborhood amenities are local public goods, i.e., they are non-rival and non-excludable to neighborhood residents, while education is not strictly a public good because it is excludable. Private schools operate even in areas with good public schools. These households appear uniformly to have been attracted to the central-city side of the subdivision out of preference for the neighborhood amenities, which are similar to those on the suburban side of the subdivision, and disinterest in the characteristics of suburban public schools.

4. Conclusions

Our results indicate that the high house and neighborhood quality on the central-city side of the subdivision has encouraged the formation of a small and informal Tiebout service district. The central-city side attracts households demographically similar to their suburban counterparts, but who have weak preferences for the characteristics of suburban public schools. The neighborhood offers an opportunity to for these households to cost-effectively send their children to nearby tuition-charging parochial schools or to special central-city magnet schools. A well-organized and active neighborhood association effectively
supplements central-city services. This provides strong evidence both of a “supply response” to the mismatch between house and public-services quality and of Tiebout sorting.

Interestingly, this supply response arguably treats inefficiency from restrictive public regulation. Public school districts face a variety of regulatory constraints on the characteristics of the services they provide. In particular, public schools are legally prohibited from providing religiously-oriented education. Thus the decline in central-city public-services quality and subdivision house prices provides a cost-saving opportunity for households who prefer religiously-based education. Similarly, central-city magnet schools have characteristics, such as ethnic diversity, that are difficult to supply in many suburban districts. Central-city neighborhoods with relatively high-quality housing therefore allow a response to the legal constraints on public-service characteristics.

This supply response has clearly not eliminated the large house-price differential at the public service-districts boundary. Doing so would apparently require another type of supply response: a shift in the public-services districts boundary. The location of the municipal boundary appears constrained by the requirement of a city-wide vote. The constraint on the school-district boundary is also high. So, the price differential can be explained by the rigidity of the boundary. Interestingly, though shifting the school-district boundary to include the entire subdivision in the suburban school district would increase house values, it would also increase property taxes. It is possible that most of the households on the central-city side prefer to keep the boundary where it is (at least until they choose to leave the neighborhood).

The results suggest that analysis of standard municipal or census-tract demographic data probably understates the extent of Tiebout sorting. Tiebout sorting can occur across the neighborhoods within formal service districts, indeed within census tracts. In general, neighborhoods do not conform to commonly-analyzed census boundaries, such as census tracts. And analyzing census demographic statistics, even at the appropriate geography, would not have revealed the Tiebout sorting indicated by our survey because preferences can differ even across demographically similar households.
REFERENCES


Table 1. Current Characteristics of the Population of Subdivision Houses

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Median</th>
<th>Std Dev</th>
<th>Min</th>
<th>Max</th>
</tr>
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<tbody>
<tr>
<td><strong>East Grand Rapids</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Floor space (sq ft)</td>
<td>2589</td>
<td>2551</td>
<td>706</td>
<td>1000</td>
<td>4993</td>
</tr>
<tr>
<td>Year Built</td>
<td>1940</td>
<td>1939</td>
<td>12.4</td>
<td>1919</td>
<td>1999</td>
</tr>
<tr>
<td>Baths</td>
<td>2.79</td>
<td>2.5</td>
<td>0.80</td>
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<td>5</td>
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<tr>
<td>Lot area (sq ft)</td>
<td>12,475</td>
<td>12,000</td>
<td>4,828</td>
<td>5,590</td>
<td>27,300</td>
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<tr>
<td>Garage space (sq ft)</td>
<td>484</td>
<td>450</td>
<td>140</td>
<td>216</td>
<td>1446</td>
</tr>
<tr>
<td><strong>Grand Rapids</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Floor space (sq ft)</td>
<td>2190</td>
<td>2112</td>
<td>498</td>
<td>1081</td>
<td>4345</td>
</tr>
<tr>
<td>Year Built</td>
<td>1931</td>
<td>1927</td>
<td>8.25</td>
<td>1922</td>
<td>1956</td>
</tr>
<tr>
<td>Baths</td>
<td>1.97</td>
<td>1.5</td>
<td>0.71</td>
<td>1</td>
<td>5.5</td>
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<tr>
<td>Lot area (sq ft)</td>
<td>7281.4</td>
<td>6500</td>
<td>2481</td>
<td>3953</td>
<td>23,098</td>
</tr>
<tr>
<td>Garage space (sq ft)</td>
<td>397</td>
<td>399</td>
<td>87.7</td>
<td>0</td>
<td>850</td>
</tr>
</tbody>
</table>

There are 193 houses in the East Grand Rapids portion, and 255 houses in the Grand Rapids portion.

Table 2. Current Characteristics of Houses in the Sample

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Median</th>
<th>Std Dev</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>East Grand Rapids</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Floor space (sq ft)</td>
<td>2689</td>
<td>2660</td>
<td>470</td>
<td>1621</td>
<td>3571</td>
</tr>
<tr>
<td>Year Built</td>
<td>1929</td>
<td>1929</td>
<td>2.37</td>
<td>1923</td>
<td>1934</td>
</tr>
<tr>
<td>Baths</td>
<td>2.92</td>
<td>2.5</td>
<td>0.63</td>
<td>1.5</td>
<td>4.5</td>
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<tr>
<td>Lot area (sq ft)</td>
<td>9955</td>
<td>9810</td>
<td>2960.5</td>
<td>5590</td>
<td>18,893</td>
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<td>Garage space (sq ft)</td>
<td>445.5</td>
<td>407</td>
<td>116.0</td>
<td>220</td>
<td>915</td>
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<tr>
<td><strong>Grand Rapids</strong></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Floor space (sq ft)</td>
<td>2486</td>
<td>2439</td>
<td>543.8</td>
<td>1640</td>
<td>3599</td>
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<tr>
<td>Year Built</td>
<td>1927.2</td>
<td>1927</td>
<td>2.40</td>
<td>1923</td>
<td>1935</td>
</tr>
<tr>
<td>Baths</td>
<td>2.22</td>
<td>2.5</td>
<td>0.77</td>
<td>1.5</td>
<td>4</td>
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<td>Lot area (sq ft)</td>
<td>8140</td>
<td>6790</td>
<td>3520</td>
<td>4615</td>
<td>23,098</td>
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<tr>
<td>Garage space (sq ft)</td>
<td>400.0</td>
<td>400</td>
<td>70.7</td>
<td>228</td>
<td>600</td>
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There are 50 houses in the sample on each side of the urban boundary, 100 houses in total.
Table 3. Regression Results

<table>
<thead>
<tr>
<th></th>
<th>Price Indices</th>
<th>Boundary Differential since 1991</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sales since 1949</td>
<td>Sample sales</td>
</tr>
<tr>
<td>Floor space (100s of sq ft)</td>
<td>0.0149 (4.61)</td>
<td>0.0184 (3.54)</td>
</tr>
<tr>
<td>Lot size (1000s of sq ft)</td>
<td>0.0277 (5.21)</td>
<td>0.0352 (4.05)</td>
</tr>
<tr>
<td>Baths</td>
<td>0.0901 (4.60)</td>
<td>0.0551 (1.60)</td>
</tr>
<tr>
<td>Garage size (100s of sq ft)</td>
<td>-0.0001 (0.00)</td>
<td>0.0210 (0.90)</td>
</tr>
<tr>
<td>Age at sale (decades)</td>
<td>0.0483 (0.94)</td>
<td>0.0673 (0.81)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Sale date (years)</th>
<th>EGR dummy (decades)</th>
<th>EGR*sale date (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.0722 (5.96)</td>
<td>0.3710 (1.17)</td>
<td>-0.0046 (0.44)</td>
</tr>
<tr>
<td></td>
<td>(17.66)</td>
<td>(10.63)</td>
<td>(0.98)</td>
</tr>
<tr>
<td>Number of observations</td>
<td>359</td>
<td>95</td>
<td>372</td>
</tr>
<tr>
<td>Adj R-squared</td>
<td>0.953</td>
<td>0.849</td>
<td>0.886</td>
</tr>
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</table>

t-statistics in parentheses.
Dependent variable is the natural log of sale price.
Table 4. Demographic Characteristics

<table>
<thead>
<tr>
<th></th>
<th>Subdivision (block data)</th>
<th>Remainder of Census Tract</th>
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<tbody>
<tr>
<td></td>
<td>Central City</td>
<td>Suburb</td>
</tr>
<tr>
<td><strong>Household Type</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Married-couple family</td>
<td>197</td>
<td>158</td>
</tr>
<tr>
<td>Male-headed family</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Female-headed family</td>
<td>14</td>
<td>10</td>
</tr>
<tr>
<td>One person</td>
<td>24</td>
<td>19</td>
</tr>
<tr>
<td>Unrelated persons</td>
<td>12</td>
<td>3</td>
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<tr>
<td><strong>Household Tenure</strong></td>
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<tr>
<td>Owner-occupiers</td>
<td>248</td>
<td>188</td>
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<tr>
<td>Renters</td>
<td>1</td>
<td>3</td>
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<tr>
<td><strong>Total Households</strong></td>
<td>249</td>
<td>191</td>
</tr>
<tr>
<td><strong>Age</strong></td>
<td></td>
<td></td>
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<tr>
<td>Under 18</td>
<td>242</td>
<td>208</td>
</tr>
<tr>
<td>18-64</td>
<td>467</td>
<td>334</td>
</tr>
<tr>
<td>Over 65</td>
<td>65</td>
<td>61</td>
</tr>
<tr>
<td><strong>Race</strong></td>
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<tr>
<td>White</td>
<td>653</td>
<td>578</td>
</tr>
<tr>
<td>Black</td>
<td>92</td>
<td>7</td>
</tr>
<tr>
<td>Other</td>
<td>29</td>
<td>18</td>
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<tr>
<td><strong>Total Population</strong></td>
<td>774</td>
<td>603</td>
</tr>
<tr>
<td><strong>Med Household Income</strong></td>
<td>NA*</td>
<td>NA</td>
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* Median household income is available at the census tract, but not the block, level.
### Table 5. Survey Results

<table>
<thead>
<tr>
<th></th>
<th>Suburb</th>
<th>Central City</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Children</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Households with children</td>
<td>63 (92.6%)</td>
<td>62 (86.0%)</td>
</tr>
<tr>
<td>Average number of kids</td>
<td>2.43</td>
<td>2.44</td>
</tr>
<tr>
<td>Median number of kids</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td><strong>School Choice (HHs w/children)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attended only public school</td>
<td>48 (76.2%)</td>
<td>15 (24.2%)</td>
</tr>
<tr>
<td>Attended only private school</td>
<td>5 (7.9%)</td>
<td>27 (43.5%)</td>
</tr>
<tr>
<td>Attended a mix of public &amp; private</td>
<td>10 (15.9%)</td>
<td>20 (32.3%)</td>
</tr>
<tr>
<td>At least half time public</td>
<td>9 (14.3%)</td>
<td>10 (16.1%)</td>
</tr>
<tr>
<td>At least half time private</td>
<td>1 (1.6%)</td>
<td>10 (16.1%)</td>
</tr>
<tr>
<td>Total with kids</td>
<td>63</td>
<td>62</td>
</tr>
<tr>
<td><strong>Neighborhood choice (HHs w/children)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moved to send kids to public school</td>
<td>51 (80.9%)</td>
<td>13 (21.0%)</td>
</tr>
<tr>
<td>Moved to send kids to private school</td>
<td>3 (4.8%)</td>
<td>20 (32.3%)</td>
</tr>
<tr>
<td>Liked the option of public/private</td>
<td>5 (7.9%)</td>
<td>3 (4.8%)</td>
</tr>
<tr>
<td>Moved w/out consideration of school</td>
<td>4 (6.4%)</td>
<td>26 (41.9%)</td>
</tr>
<tr>
<td>Total with kids</td>
<td>63</td>
<td>62</td>
</tr>
<tr>
<td><strong>Total responses</strong></td>
<td>68</td>
<td>72</td>
</tr>
</tbody>
</table>
Figure 1. Grand Rapids Annexations and East Grand Rapids
Figure 2. Plat of the Subdivision

Municipal and School District Boundaries
Figure 3. Distribution of the Number of Subdivision Houses Built Over Time, East GR Versus GR

Figure 4. House Sales per Year in the 100-House Sample
Figure 5. Sale Price per Square Foot, 1949 – 2002
Figure 6. Fourier Time Trends in the Natural Log of Sale Price, 1950 – 2002

Figure 7. Trend and 95% Confidence Interval in the Ten-Year Average Boundary Differential