Urban Studies
47(11) 2409–2426, October 2010

Comparing the Capitalisation Benefits of Light-rail Transit and Overlay Zoning for Single-family Houses and Condos by Neighbourhood Type in Metropolitan Phoenix, Arizona

Carol Atkinson-Palombo

[Paper first received, May 2008; in final form, August 2009]

Abstract

Light rail transit (LRT) is increasingly accompanied by overlay zoning which specifies the density and type of future development to encourage landscapes conducive to transit use. Neighbourhood type (based on land use mix) is used to partition data and investigate how pre-existing land use, treatment with a park-and-ride (PAR) versus walk-and-ride (WAR) station and overlay zoning interrelate. Hedonic models estimate capitalisation effects of LRT-related accessibility and overlay zoning on single-family houses and condos in different neighbourhoods for the system in metropolitan Phoenix, Arizona. Impacts differ by housing and neighbourhood type. Amenity-dominated mixed-use neighbourhoods—predominantly WAR communities—experience premiums of 6 per cent for single-family houses and over 20 per cent for condos, the latter boosted an additional 37 per cent by overlay zoning. Residential neighbourhoods—predominantly PAR communities—experience no capitalisation benefits for single-family houses and a discount for condos. The results suggest that land use mix is an important variable to select comparable neighbourhoods.

1. Empirical Literature, Theoretical Foundations and Motivation for Study

Light rail transit (LRT) is an increasingly popular technology used to produce urban environments that are ostensibly more sustainable. Traditional theories of land economics suggest that improving the surface of accessibility by adding LRT to urban environments will increase land values and promote development of more compact environments clustered onto the spine of transit (Fujita, 1989). Empirical

Carol Atkinson-Palombo is in the Department of Geography, University of Connecticut, 215 Glenbrook Road, Storrs, Connecticut, 06269-4148 USA. E-mail: carol.atkinson-palombo@uconn.edu.

0042-0980 Print/1360-063X Online

DOI: 10.1177/0042098009357963

research of numerous systems built in the 1980s and 1990s revealed that overlaying rail systems onto streetscapes configured for the automobile had little impact on land use patterns (Landis *et al.*, 1995). Research into barriers to land use change in contemporary cities (TCRP, 1997) led to the formulation of a set of best practices to encourage land use change (Belzer *et al.*, 2003; TCRP, 2002, 2004). Current thinking is that urban transport and land use planning need to be integrated and include tools to ensure that density, design and the mix of development are conducive to transit—a concept known as transit-oriented development (TOD) (Calthorpe, 2003; Cervero and Kockelman, 1997; Downs, 1992, 1997; Duaney *et al.*, 2001).

Case studies of individual station areas or projects have shown that not all locations within a given system have the capacity to generate pedestrian- and transit-friendly environments (Breznau, 2003; Feigon *et al.*, 2003; Leach, 2003; Ohland, 2003a, 2003b). It is becoming increasingly understood that various stations serve different but complementary functions within a given system (Dittmar and Poticha, 2003). Some stations—for example, those in downtowns with a high concentration of employment and entertainment—are effectively destinations. At the other end of the node–destination spectrum described by Bertolini and Split (1998) some stations need to host the parking lots that are essential to expanding the commuter-shed or coverage of the system and to ensure that LRT integrates with other modes of transport within the region. Variations in station function were captured by Dittmar and Poticha (2003) in a typology that defined six common classes of TOD and distinguished their roles within regional systems: urban downtown, urban neighbourhood, suburban town centre, suburban neighbourhood, neighbourhood transit zone and commuter town.

Numerous benefits of TOD are cited in the literature, but few agreed-upon ways to measure impacts exist aside from studies that focus on land prices, ridership and reductions in VMT (Renne and Wells, 2005). Even for a seemingly straightforward study of capitalisation benefits, disentangling the effects that may result from LRT-related changes in accessibility from those generated by supplementary policies such as changes in zoning to increase density and shape the design and composition of urban development, is challenging.[1] Statistically, it is difficult to separate out the importance of being close to transit stops from public policy incentives, like zoning bonuses, in explaining land value increases. In many instances, they are likely to be co-dependent, with zoning incentives necessary if proximity to transit is to yield dividends and proximity to transit necessary if density bonuses and other zoning 'perks' are to pay off (TCRP, 2004).

Despite these challenges, many studies have been undertaken to investigate the relationship between LRT and the land markets, theoretically the precursor to land use change (see Hess and Lombardi, 2004, and Duncan, 2008, and the references therein for extensive reviews).[2] One limitation of the majority of existing studies is that they have quantified the effect of LRT on single-family houses because the data are more abundant and more readily available (see Cervero and Duncan, 2001, for further details). A recent contribution to the literature pertinent to this study is a comparative study of the capitalisation benefits of LRT in San Diego on single-family houses and condominiums (Duncan, 2008). He found that condominiums—which he argued are probably a better reflection of the density preferences of the TOD market than single-family houses—experienced higher capitalisation benefits than single-family houses (17 per cent versus 6 per cent).

Duncan's (2008) study is important because preferences about housing density are fundamental to LRT/TOD and new urbanism more generally, where the emphasis is on providing an alternative to suburban living (Dittmar and Poticha, 2003; Duaney *et al.,* 2001). Scholars of housing policy and planning believe that a niche market exists for downtown housing consisting of people with preferences for proximity not only to centrally located jobs but also to nightlife, urban amenities and vibrant urban environments (Danielsen *et al.,* 1999; Farris, 2001; Lang and Danielsen, 2005; Lang *et al.,* 1997; Sohmer and Lang, 2001). Evidence is also mounting that people's preferences are shifting towards smaller lot/house sizes and shorter commutes in the face of uncertainty about global oil prices in a post-peak-oil era and increasing recognition of the need to reduce greenhouse gas emissions (Ewing *et al.,* 2008). Researchers have suggested that demand for high-density, mixed-use housing far outstrips supply (see Ewing *at al.*, 2008, and the references therein), while others have shown that people live at lower densities than they would like (Levine and Frank, 2007; Levin and Inam, 2004). Heterogeneous preferences have been incorporated into both simulation models (examples include Brown and Robinson, 2006; Fernandez *et al.*, 2005) and hedonic models (Bourassa *et al.*, 2003; Fik *et al.*, 2003; Goodman and Thibodeau, 1998; Michaels and Smith, 1990).

A recent study by Kahn (2007), in which he investigated the impact of 14 rail systems built in the US from 1970 to 2000 on neighbourhood demographics, highlighted two additional points of relevance to this paper. First, is a distinction between stations with/without a parking lot—which he defined as park-and-ride (PAR) and walk-and-ride (WAR) communities. The rationale for quantifying these effects separately was that WAR communities were more likely to offer a new urbanist lifestyle, while PAR communities may experience a lower quality of life due to increased noise, traffic and congestion. Kahn found that WAR generated a premium of 3 per cent in house prices, while PAR generated no change. In Boston, where WAR and PAR effects showed the largest divergence, WAR showed a 7 per cent increase in house prices, while PAR experienced a 5 per cent decline in house prices. The second point in Kahn's paper that is relevant to this study is his discussion and treatment of endogeneity issues in the modelling process. Research on infill projects and on NIMBY-ism in general suggests that pre-existing land use—intertwined with pre-existing zoning—and community capital will influence what type of TOD evolves at each station area because transport agencies tend to follow the path of least resistance (Altshuler and Luberoff, 2003; Dear, 1992; Farris, 2001; Lake, 1993). This suggests the need for greater consideration of how transport, land use and land prices interrelate.

In this study, I take as my starting-point the theory that decisions to build LRT and enact overlay zoning to encourage TOD trigger a well-accepted process of location sorting whereby those who value proximity to LRT and the amenities integral to TOD outbid others for station locations. The basic assumption that LRT and the TOD associated with some of the station areas are built to appeal to those seeking higher-density living environments raises a question not only about the effectiveness of using data for single-family house prices to estimate the impacts of urban transit and associated policies (as articulated by Duncan, 2008), but also a methodological issue about the selection of comparables for modelling purposes. Existing studies have not adequately quantified how capitalisation benefits for one or more categories of land use vary in different types of land use setting across a given system. I argue that more consideration needs to be given to comparability of neighbourhoods in the hedonic modelling process. By that, I mean moving beyond incorporating land use into hedonic models in the form of independent variables

(Al-Mosaind *et al.*, 1995; Chen *et al.*, 1998; Duncan, 2008; Nelson, 1999), to using land use mix as a means of partitioning datasets to create subsets of observations to compare capitalisation impacts in similar geographical settings.

Accordingly, I use data for the LRT system in metropolitan Phoenix, Arizona, that began operating in December 2008, to inform on how decisions to build LRT and add overlay zoning to existing zoning affect land prices in different geographical settings within the transport corridor.[3] Four research questions are

(1) What combinations of land use mix—or neighbourhood type—exist within the transit corridor?
(2) What is the relationship between neighbourhood type and whether a single-family house or condo in an LRT station area has been subject to overlay zoning?
(3) What is the relationship between neighbourhood type and whether or not a station is a PAR or a WAR? and
(4) How do capitalisation benefits differ for single-family houses and condos[4] in different types of land use setting?

This study adds to the existing body of literature by using categorical variables based on land use mix to partition data to estimate how the capitalisation effects of LRT and overlay zoning vary in different geographical settings within a given system in its planning and construction phases. This approach ties recent work on TOD typologies to the capitalisation literature, takes into account endogeneity issues and allows the results to be evaluated within the context of density preferences. Section 2 contains details of the data and analysis; section 3 contains the results; and section 4 comprises a discussion of the theoretical and methodological implications and policy significance of the study.

2. Methodology

2.1 Light Rail in Metropolitan Phoenix, Arizona

In the past 50 years, metropolitan Phoenix has experienced rapid growth in population, urbanised area and vehicle miles travelled (Gober, 2005; Gober and Burns, 2002). For much of that period, transport policy focused almost exclusively on the automobile (Abbitt, 1990; ARPA, 2006). Public transit—in one form or another—was on the public ballot in Maricopa County for over two decades, with LRT feasibility studies dating back to 1994 (ARPA, 2006; City of Phoenix, 2002, 2004). Although the type of transit has varied over the past two decades, the route has consistently linked major employment centres on Central Avenue with downtown Phoenix, Sky Harbor Airport and downtown Tempe (see Figure 1). Following numerous unsuccessful votes, Prop2000 was passed by City of Phoenix voters in 2000 to fund the majority of the system, to finalise all but one of the station areas and to draft an ordinance to add overlay zoning along the transit route. The system consists of 20.3 miles of at-grade track that joins the downtowns of Phoenix, Tempe and Mesa and 27 stations in a variety of neighbourhoods, commercial districts and an industrial zone.

The case study presents a unique opportunity to separate out the effects of LRT-related accessibility and zoning. Planners at the City of Phoenix strategically implemented zoning ahead of system construction, potentially to accelerate development in station areas of land uses conducive to transit (City of Phoenix, 2002, 2004; City of Tempe, 2006; MAG, 2003, 2007). In Phoenix, a draft transit-overlay zoning ordinance began to circulate in 2000. Areas subject to zoning were determined through the participatory planning process. In Tempe, formal transit-overlay zoning was not circulated until 2005, but basically grandfathered all land parcels located within

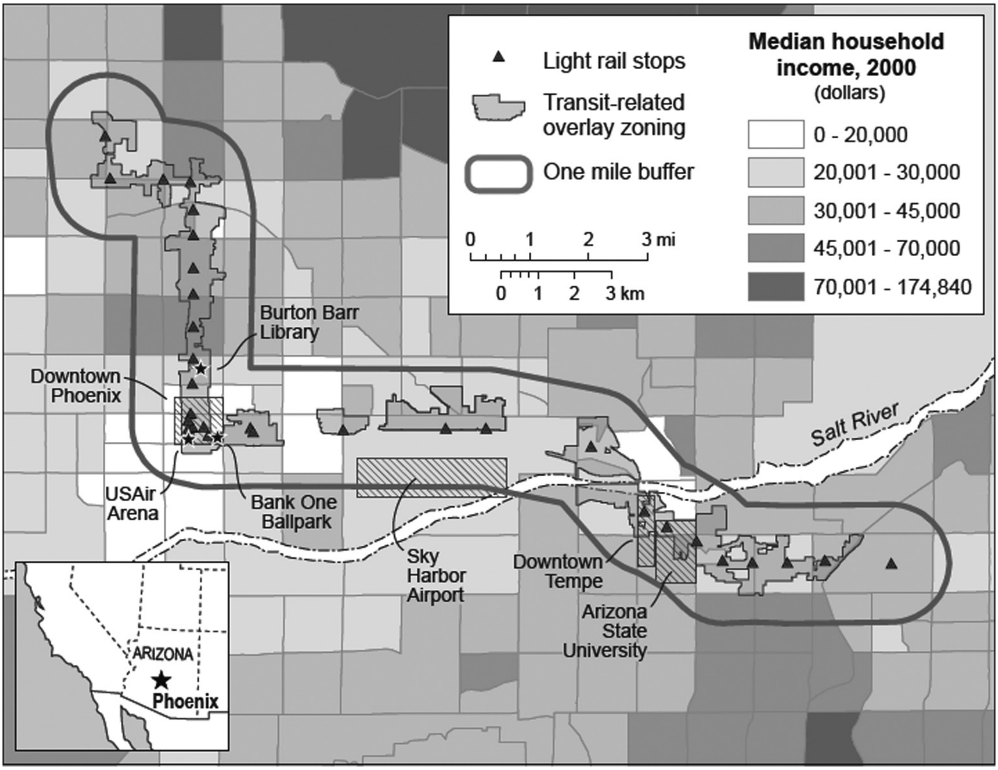

Figure 1. Light rail system in metropolitan Phoenix, Arizona.

redevelopment zones (City of Tempe, 1997). Areas subject to overlay zoning—which tend to have excluded any large clusters of single-family houses in station areas—are shown in Figure 1. This strategic boundary decision means that in some locations transit-overlay zoning roughly corresponds to station area while in others, very little of the station area has overlay zoning, allowing the effects of zoning and accessibility to be measured separately. The period 2001–07 represented a planning and construction phase in which overlay zoning was finalised, federal funding was obtained to subsidise the system, a county-wide vote was passed to fund extensions to this initial starter segment and construction took place. Hence, I characterise 1995–99 as a period in which station locations were public knowledge but overlay zoning was not known ('before'), and 2001–07 as a period in which both station locations and overlay zoning were public knowledge ('after').

The overlay-zoning ordinance for Phoenix contains lists of land uses explicitly prohibited (such as car washes and drive-in businesses), conditionally allowed (such as sports stadiums) and explicitly allowed (mixed-use developments and multifamily housing). The ordinance defines transit-oriented development as

> a type of development that encourages transit usage by increasing the base of riders through complementary land uses such as office, retail, and housing near transit stations (City of Phoenix, 2002, p. 5).

The objective of the ordinance is to provide a

> transit-supportive environment … [that integrates] auto uses with a complementary

> mix of land uses, where streets have a high level of connectivity and the blocks are small, all within a comfortable walking and bicycling distance from light rail stations (City of Phoenix, 2002, p. 6).

Tempe's ordinance also emphasises development that both promotes alternative transport modes and encourages a mix of uses and balance of densities and intensities (City of Tempe, 2006). Specific details on maximum allowable densities and particular uses have, in both instances, been left vague.[5]

2.2 Data

The following datasets were assembled in a geographical information system:

- *Land parcels*: geo-coded parcel data and sales affidavits[6] for the most recent transaction on land parcels from 1995 through 2007. Relevant fields were: property use code, construction date, date and price of most recent sale, lot size, living area, pool size (source: Maricopa County Assessor's Office).
- *Overlay zoning*: transit-related overlay zoning (source: City of Phoenix, Valley Metro, City of Tempe).
- *Transport*: LRT alignment and station locations (source: Valley Metro, 2004); freeways (2005) (source: Arizona Department of Transport (ADOT)).
- *Census Data*: boundaries for census tracts as of 2000.

2.3 Analysis of Land Use Mix

Each parcel in the Assessor Office dataset has a land use code, which I reduced to four categories: vacant, residential, TOD-prohibited (if the land use was mentioned specifically in the overlay zoning ordinance as not allowed) and TOD-allowed (if the overlay zoning ordinance would allow that particular use of land). I fish-netted[7] the study area into equal-sized cells that approximated the location and size of the most compact census tracts, selected those cells that intersected with all land parcels within the transport corridor ($n = 61$), calculated the proportion of each type of land use in each cell and used cluster analysis to produce neighbourhood types based on land use mix.

2.4 Analysis of Overlay Zoning

An ANOVA test determined whether or not the proportion of single-family houses and condos with overlay zoning was statistically significantly different, by neighbourhood type.

2.5 Analysis of PAR and Neighbourhood Type

An ANOVA test determined whether there were statistically significant differences in the proportion of LRT stations with a parking lot, by neighbourhood type.

2.6 Transaction Data

I selected all single-family houses that were sold in either 1995–99 ('before') and 2001–07 ('after').[8] A second dataset included all condos[9] with transactions in 1995–99 ('before') and 2001–07 ('after').[10]

2.7 Hedonic Models

The generalised form of the hedonic price model for housing is as follows, where P is the selling price, **L** is a combination of lot-specific characteristics, **N** is a combination of neighbourhood traits, and **T** is a combination of LRT-related variables.

$$P = \mathrm{f}(\mathbf{L},\mathbf{N},\mathbf{T}) \tag{1}$$

This may be expanded to

$$P = \mathrm{f}(\mathbf{L},\mathbf{N},\mathbf{T}) = \beta_0 + \Sigma\beta_1\mathbf{L} + \Sigma\beta_2\mathbf{N} + \Sigma\beta_3\mathbf{T} + t + \varepsilon \tag{2}$$

where, β_0 is the constant term; β_1 is the regression coefficient of lot-specific attributes **L**; β_2 is the regression coefficient of neighbourhood-specific attributes **N**; β_3 is the regression coefficient of LRT-related attributes **T**; t is time; and ε is a stochastic or error term.

Variables were used to reflect lot-specific characteristics, neighbourhood-specific attributes and LRT-related attributes.[11] Lot-specific variables (**L**) are: *Lot* (the size of the land parcel in square feet), *Liv* (the residential living square footage in the property),[12] *Pool* (a binary variable that reflects whether or not a unit has a private swimming pool), and five binary variables that group the age of housing by era of construction (pre-1920, 1921–45, 1946–70, 1971–90 and post-1990). Neighbourhood variables (**N**) are: *DistFree* (the straight-line distance to the nearest freeway in feet), *DistAmen* (the straight-line distance to PVI or peak-value intersection in the nearest downtown, either Tempe or Phoenix); and binary variables for each of the 54 census tracts in the study area. LRT-related (**T**) variables are *BinaryWD* (a binary variable that describes whether or not a land parcel is within a half-mile walking distance of a proposed LRT station or not)[13] and *BinaryTOD* (a binary variable that describes whether or not a land parcel is subject to overlay zoning).[14]

All of the variables in vectors **L** and **N** are statistical controls. The variables of interest in this study are in the **T** vector—*BinaryWD* and *BinaryTOD*. In order to control for the effects of time, 49 dummy variables were included in the models for each quarter from Q1 1995 through Q1 2007. I used a semi-log specification because it was robust to various problems (Cropper *et al.*, 1988).

2.8 Hypotheses

RQ(1). Location theory and the empirical analysis conducted by Dittmar and Poticha (2003) suggest that various types of neighbourhood will exist along the alignment, but the specific categories are an open question.

RQ(2). Theories of NIMBY-ism (Dear, 1992; Pendall, 1999) suggest that some residential communities will have more influence than others in opposing overlay zoning.

RQ(3). Theories of land economics (Fujita, 1989) suggest that locations with a high proportion of land use devoted to amenities will not have a parking lot because other land uses will be more valuable.

RQ(4). The variable *BinaryWD* should be statistically significant and positive in both the 'before' and 'after' periods (because station locations were publically known) for station areas with WAR, but lower for station areas with PAR because of the noise and congestion associated the station-area parking lots reduce the capitalisation benefits associated with improved accessibility.

Because overlay zoning allows for more dense future development, theories of profit-maximisation suggest that *BinaryTOD* should be positive and significant in the 'after' period, when it was known in the market, and statistically insignificant in the 'before' period (Fujita, 1989). The coefficients for both *BinaryWD* and *BinaryTOD* should be greater for condos than for single-family houses because this housing type is a better reflection of self-selectors' density preferences. Similarly, theories of location sorting and associated empirical research (Matthews and Turnbull, 2007; Plaut and Boarnet, 2003; Tu and Eppli, 1999) suggest that the coefficients for *BinaryWD* should be higher in neighbourhoods that offer a new urbanist lifestyle, than those that are more traditionally residential.

The coefficients of the control variables, *Lot*, *LivSqFt* and *Pool*, should be positive indicating that the greater the values, the higher the sale price. *DistAmen*, the Euclidian distance to the nearest downtown—either Tempe or Phoenix—should be negative, indicating that the closer to downtown, the higher the property price. The sign of *DistFree* could be either positive or negative depending on whether proximity to freeways is considered a nuisance or benefit.[15]

Table 1. Neighbourhood types (percentages)

Land use	*Type 1 Amenity-rich (n = 26)*	*Type 2 Residential-dominated mixed used (n = 4)*	*Type 3 Amenity-rich with vacant land (n = 5)*	*Type 4 Amenity-dominated mixed use (n = 13)*	*Type 5 Residential (n = 13)*
TOD-allowed	79	29	46	42	21
TOD-prohibited	3	14	6	16	7
Vacant	15	16	45	12	5
Residential	2	42	3	31	67

3. Results

3.1 Cluster Analysis

The cluster analysis produced five discrete types of land use mix. The values for each cluster centre are shown in Table 1. Two neighbourhood types—amenity-rich areas with (type 3) and without (type 1) large amounts of vacant land—had very little residential land use (2 per cent and 3 per cent respectively). One set of neighbourhoods—type 5—was dominated by residential, comprising two-thirds of all land use by area. The remaining two neighbourhood types were mixed use, dominated by residential (type 2) and amenities (type 4). The results suggest that separate hedonic analyses need to be conducted in neighbourhood types 4 and 5 for single-family houses and condos.

3.2 Neighbourhood Type and Overlay Zoning

Overall, 9 per cent of single-family houses within walking distance of LRT stations were subject to overlay zoning, but there were statistically significant differences at the 0.0001 level in the average percentage by neighbourhood type (Table 2). Few single-family houses were present in neighbourhood types 1, 2 and 3 (suggesting again that these types of neighbourhood and the houses within them may skew the results if used in a 'global' model). Single-family houses in neighbourhood type 5 were less likely (6.7 per cent) than neighbourhood type 4 (10.5 per cent) to have overlay zoning. Condos in neighbourhood type 4 were four times as likely to have overlay zoning as condos in neighbourhood type 5 (43.9 per cent versus 11.9 per cent) and four times as likely as a single-family house

Table 2. Percentage of housing units subject to overlay zoning, by neighbourhood type

	Single-family houses		*Condos*	
Neighbourhood type	*N*	*Percentage of housing units subject to overlay zoning*	*N*	*Percentage of housing units subject to overlay zoning*
1	11	9.1	265	67.5
2	3	0.0	31	0.0
3	6	33.3	277	70.8
4	2001	10.5	1220	43.9
5	2027	6.7	674	11.9
Total	4048	9.0	2467	40.0

Table 3. Park-and-ride (PAR), by neighbourhood type

Neighbourhood type	*PAR stations*	
	N	*Percentage*
1	0	0.0
2	0	0.0
3	0	0.0
4	1	12.5
5	7	87.5
Total	8	

in the same type of neighbourhood to have overlay zoning.

3.3 Neighbourhood Type and PAR/WAR

There were statistically significant differences at the 0.0001 level in the type of neighbourhood that was treated with a PAR station (Table 3). Seven out of the eight PAR stations were located in residential neighbourhoods and one was located in an amenity-dominated mixed-use area. The remaining 19 WAR stations were distributed across the various neighbourhood types.

3.4 Capitalisation Effects

The transaction data were partitioned according to the neighbourhood types obtained in the cluster analysis. Descriptive statistics for single-family houses and condos in amenity-dominated mixed-used neighbourhoods (type 4) and residential neighbourhoods (type 5) are in Table 4, divided by property type and whether or not transaction took place 'before' or 'after' overlay zoning was adopted. Of note is that overlay zoning is more frequent in amenity-dominated mixed-use neighbourhoods than in residential neighbourhoods, for both single-family houses (3 per cent versus 1 per cent) and condos (13 per cent versus 3 per cent).

Two sets of hedonic models were run for neighbourhood types 4 and 5, for 'before'/'after'. Individual coefficients are shown in Tables 5 (single-family houses) and 6 (condos).[16]

The two LRT-related variables are binary and thus the coefficients can be interpreted as percentage change in the dependent variable in the presence/absence of that characteristic.[17] For single-family houses in amenity-dominated mixed-use neighbourhoods, being within walking distance of an LRT station resulted in a 6 per cent premium in house price and overlay zoning was statistically insignificant. For single-family houses in residential neighbourhoods, the *coefficient* for *BinaryWD* was statistically insignificant and the coefficient for *BinaryTOD* was significant at the 0.05 level and strongly negative. Being within walking distance of an LRT station in a residential neighbourhood—which are primarily PAR versus WAR—produces no capitalisation benefit and, in fact, houses in these types of neighbourhood that are subject to overlay zoning sold at a 12 per cent price discount compared with those without overlay zoning.

The coefficients of *BinaryWD* and *BinaryTOD* for condos in mixed-use amenity-dominated neighbourhoods and residential neighbourhoods showed a strong divergence. In mixed-use amenity neighbourhoods, the coefficients for *BinaryWD* were 0.28 for 'before' and 0.16 for 'after' indicating that condos that were treated with LRT sold at a premium of 28 per cent and 16 per cent higher relative to condos in similar neighbourhoods without LRT. A difference of means test confirmed that the *BinaryWD* coefficients in these two regressions were statistically significantly different at the 0.02 level (Paternoster *et al.*, 1998). The 0.37 coefficient for *BinaryTOD* in the 'after' period indicates that overlay zoning leveraged the capitalisation benefits afforded by LRT-related accessibility by a further 37 per cent. In contrast, in residential neighbourhoods, being treated with an LRT station resulted in a 13 per cent discount for condo prices in the 'before' period, while the negative and statistically significant coefficient

Table 4. Descriptive statistics of housing transactions 'before' overlay zoning was announced (1995–99) and 'after' (2001–07)

	Before		*After*	
Variable	*Mean*	*S.D.*	*Mean*	*S.D.*
Single-family houses in amenity-dominated mixed-use neighbourhoods (type 4)				
Lot	7817	2484	7687	2685
Living area (square ft)	1350	501	1306	451
Pool[a]	0.14	0.35	0.14	0.35
Distance to freeway	4512	2708	4328	2615
Distance to nearest downtown	3718	2949	3918	2971
BinaryWD[a]	0.34	0.48	0.36	0.48
BinaryTOD[a]	0.03	0.18	0.03	0.17
n	732		1838	
Single-family houses in residential neighbourhoods (type 5)				
Lot	8738	3973	8522	2976
Living area (square ft)	1485	457	1477	435
Pool[a]	0.23	0.42	0.24	0.43
Distance to freeway	5162	2768	5044	2781
Distance to nearest downtown	3224	2229	3222	2274
BinaryWD[a]	0.19	0.39	0.17	0.37
BinaryTOD[a]	0.01	0.10	0.01	0.11
n	1725		4030	
Condos in amenity-dominated mixed-use neighbourhoods (type 4)				
Lot	1184	508	1128	473
Living area (square ft)	1090	333	1035	308
Pool[a]	0.00	0.00	0.00	0.00
Distance to freeway	4814	2562	5226	2799
Distance to nearest downtown	4591	3208	4255	3155
BinaryWD[a]	0.46	0.50	0.37	0.48
BinaryTOD[a]	0.13	0.33	0.10	0.30
n	259		882	
Condos in residential neighbourhoods (type 5)				
Lot	1250	567	1128	522
Living area (square ft)	1078	301	1025	272
Pool[a]	0.00	0.00	0.00	0.00
Distance to freeway	4393	1980	4896	2511
Distance to nearest downtown	2884	2303	2819	2339
BinaryWD[a]	0.11	0.32	0.13	0.34
BinaryTOD[a]	0.03	0.18	0.03	0.16
n	644		2427	

[a] Binary variable.

Table 5. Key hedonic model coefficients for single-family houses

	Before		*After*	
	Coefficient	*T-statistic*	*Coefficient*	*T-statistic*
Single-family houses in amenity-dominated mixed-use neighbourhoods (type 4)				
Constant	11.197**	111.296	11.965**	149.045
Lot	0.008**	4.354	0.006**	2.482
LivSqFt	0.373**	12.172	0.398**	16.500
Pool[a]	0.157**	5.884	0.059**	2.739
DistFree	–0.027**	–2.431	–0.027**	–21.650
DistAmen	–0.004**	–0.660	–0.004**	2.891
BinaryWD[a]	0.059**	2.197	0.057**	2.664
BinaryTOD[a]	–0.034	–0.596	0.019	0.381
Adjusted R^2	0.76		0.74	
Single-family houses in residential neighbourhoods (type 5)				
Constant	10.722**	241.636	11.378**	287.238
Lot	0.012**	6.017	0.016**	9.026
LivSqFt	0.362**	24.087	0.341**	24.901
Pool[a]	0.071**	6.022	0.071**	6.858
DistFree	0.023**	5.181	0.016**	4.337
DistAmen	–0.017**	–3.643	–0.009**	–2.244
BinaryWD[a]	0.010	0.676	–0.013	–0.966
BinaryTOD[a]	–0.042	–0.979	–0.118**	–2.724
Adjusted R^2	0.69		0.66	

[a] Binary variable.
Notes: ** p-value < 0.05. Coefficients for *Lot*, *LivSqFt*, *DistFree* and *DistAmen* have been multiplied by 1000. Dummy variables for each quarter of each year, census tract and age of housing are not shown.

for *BinaryTOD* indicates that overlay zoning created an additional discount. The signs of the control coefficients were as expected and their magnitudes appeared reasonable. The average values of the adjusted R^2 for the single-family and condo regressions were 72 per cent and 68 per cent respectively, at the lower end of the range for similar studies.

3.5 Spatial Autocorrelation

Standard tests of spatial autocorrelation in each of the model's residuals were carried out (Cliff and Ord, 1973). The Moran's I was found to be statistically significant in two cases, but small (at 0.01 for single-family houses in neighbourhood type 5 'before', and 0.24 for condos in neighbourhood type 5 'before') and deemed not to be problematic.

4. Evaluation and Conclusions

The analysis suggests that land use mix or neighbourhood setting shapes whether or not an LRT station is a WAR or a PAR, and whether or not land parcels are subject to overlay zoning, and that these two factors influence the subsequent process of location sorting. The capitalisation benefits associated

Table 6. Key hedonic model coefficients for condos

	Before		*After*	
	Coefficient	*T-statistic*	*Coefficient*	*T-statistic*
Condos in amenity-dominated mixed-use neighbourhoods (type 4)				
Constant	9.730**	45.601	10.900**	66.634
Lot	0.034**	3.450	0.061**	2.362
LivSqFt	0.828**	10.818	0.678**	11.591
Pool[a]	N/A	N/A	N/A	N/A
DistFree	−0.083**	−5.762	−0.080**	−7.037
DistAmen	0.032**	4.349	0.052**	8.880
BinaryWD[a]	0.282**	6.015	0.164**	4.657
BinaryTOD[a]	0.001	0.008	0.373**	3.236
Adjusted R^2	0.74		0.53	
Condos in residential neighbourhoods (type 5)				
Constant	9.804**	104.299	10.726**	156.768
Lot	0.023**	3.349	0.007**	2.671
LivSqFt	0.693**	16.816	0.628**	20.592
Pool[a]	N/A	N/A	N/A	N/A
DistFree	0.031**	4.023	0.007**	2.863
DistAmen	0.000**	3.202	0.004**	2.527
BinaryWD[a]	−0.130**	−4.602	0.034**	2.514
BinaryTOD[a]	0.038	0.762	−0.111**	−2.685
Adjusted R^2	0.73		0.60	

[a] Binary variable.

Notes: ** p-value < 0.05. Coefficients for *Lot*, *LivSqFt*, *DistFree* and *DistAmen* have been multiplied by 1000. Dummy variables for each quarter of each year, census tract and age of housing are not shown.

with LRT and overlay zoning are separately identifiable and vary according to housing type and neighbourhood setting.

Single-family houses in amenity-dominated mixed-use neighbourhoods that are treated with WAR stations sell at a premium of approximately 6 per cent ‘before’ overlay zoning is announced and 6 per cent ‘after’. These levels are within the range of existing studies showing that LRT results in a modest premium (of between 0 per cent and 10 per cent) for single-family house prices (Duncan, 2008) and comparable with the 3 per cent capitalisation benefits quantified by Kahn (2007). The appearance of capitalisation benefits as soon as stations were public knowledge is consistent with the findings of a study by Knaap *et al.* (2001), who concluded that the markets respond to plans to build transit.[18] In contrast, the absence of capitalisation benefits for single-family houses in neighbourhoods that are primarily residential and where most of the stations have a parking lot (PAR), and the detection of a 12 per cent discount if they are subject to overlay zoning, suggests a different dynamic is taking place in these neighbourhoods. The lack of capitalisation benefits could be due to the fact that primarily residential neighbourhoods do not attract the demographic associated with new urbanism (Danielsen *et al.*, 1999; Farris, 2001; Lang and Danielsen, 2005; Lang *et al.*, 1997), or that the benefits of improved accessibility associated with LRT are offset by the perception of the parking lot as a disamenity (Kahn, 2007). The discount on single-family house prices associated with overlay zoning suggests that those attracted to this type of housing in primarily residential neighbourhoods have a preference for low-density development and perceive the higher-density development associated with overlay zoning as negative.

Condos in amenity-dominated mixed-use neighbourhoods—which, as Duncan (2008) argued, may better represent more accurately the density preferences of those wishing to live near LRT—experience much higher capitalisation effects than single-family houses. The more than four-fold capitalisation effect for condos is higher in absolute terms than the 17 per cent/6 per cent difference identified by Duncan (2008), but similar in relative terms. The results reinforce Duncan's argument that existing studies using data on single-family houses to measure the capitalisation impacts of LRT may have understated its impacts. Overlay zoning—and the promise of TOD-conducive land uses in the future—adds an extra 37 per cent premium to the price of condos compared with other units in similar land use settings.

In sharp contrast to these price rises, condos that are located in neighbourhoods that are primarily residential and that have parking lots experience a price discount of 13 per cent; this is likely to be due to the increased traffic, noise and congestion associated with the parking lot. Overlay zoning in these neighbourhoods depresses prices a further 11 per cent. This outcome is not consistent with the assumptions about density preferences and warrants further investigation. One possibility raised by Kahn (2007) is the fear that transit will attract lower-income captive riders and that overlay zoning may be used to produce high-density apartment housing for lower-income populations.

Overall, the results suggest that, in the process of location sorting, neighbourhoods that experience the strongest capitalisation benefits are those most likely to evolve into TOD communities that focus on walkable neighbourhoods and mixed use, and that condos within these neighbourhoods may be more sought-after than single-family houses. The implications of this study for public policy are that decisions to build LRT and adopt overlay zoning have a highly uneven effect on different types of housing in different locations across a given system. Overlay zoning—when used in the appropriate type of neighbourhood—can enhance the capitalisation effects generated by LRT-related accessibility improvements. However, overlay zoning—or perhaps the high-density development associated with it—can also produce a discount in residential capitalisation in some neighbourhoods. Further investigation into this differential valuation of overlay zoning is needed.

The methodology used in this study, which was motivated by the emerging literature on TOD typologies, suggests that neighbourhood type (as determined by land use mix) may be a useful way to partition datasets for hedonic analyses. The theoretical implications are that the hedonic modelling of amenity-oriented treatments in urban settings needs to be tied more closely to the emerging literature on types of neighbourhood and the density preferences associated with them, and needs to deal more directly with endogeneity issues.

Suggestions for future research are adding variables to the model that can capture processes and features that are fundamental to LRT-inspired neighbourhood change. In this model, as in many other hedonic models, neighbourhood characteristics are captured by census variables at a particular point in time. While the models presented in this paper also have dummy variables to capture the effects of time, future research could investigate whether the fit of the model could be improved by including a variable with both spatial and temporal characteristics that acts as a proxy for neighbourhood change. Similarly, the general model presented in this paper contains no variable that acts as a proxy for urban design, that researchers have shown to be an important determinant of price (Matthews and Turnbull, 2007; Plaut and Boarnet, 2003; Tu and Eppli, 1999). Variables such as these may be useful for studies of LRT because of the fundamental premise that such policies are intended to provide the catalyst for the construction of new TOD communities that are designed to attract a target demographic and that both the new construction and the socio-demographic changes will be likely to affect the price of existing properties.

Notes

1. An increasingly popular way to change zoning is to add overlay zoning, which is a regulatory tool that creates a special zoning district, placed over an existing base zone(s). The overlay zoning identifies special provisions in addition to those in the underlying base zone to guide development within a special area (City of Portland, 2008).
2. Research findings on the effects of proximity to transit on land values are not very consistent, in part because impacts vary depending on the severity of traffic congestion, local real-estate market conditions, swings in business cycles and other factors (TCRP, 2004). Other sources of inconsistency include the use of different model specifications and the fact that the quality of data varies across studies. The average premium for single-family house prices in existing studies ranges from 0 per cent to 10 per cent (Duncan, 2008).
3. Defined as being within a one-mile buffer of the LRT alignment, a commonly used zone of influence (Parsons Brinckerhoff, 2001).
4. In the Assessor Office dataset, condos are individually owned and separately taxable entities, and are treated separately from multifamily housing units that tend to be rented, are taxed as a unit (i.e. all the housing units within the development) and classified as commercial properties.
5. Mesa, the municipality that contains the most eastern station, did not enact overlay zoning. Municipal dummy variables were not needed because dummy variables for each census tract were included in the models.
6. The data come from sales affidavits and are considered to be accurate for individually owned properties as they are used by the Maricopa County Assessor's Office to calculate property taxes.
7. Fish-netting is a commonly used tool in geographical analysis that is used to produce grid cells. It has long been accepted that the process is sensitive to the placement, orientation and size of the grid cell (Muller, 1977), but it does offer a means of aggregating parcel-level data.
8. Approximately 1 per cent (113) of observations was deleted from the dataset: one transaction for over \$5 million that appeared to be incorrect based on the parcel characteristics and transactions under \$20 000, reducing the dataset to 10 571 observations.
9. In this particular dataset, the designation of condo reflects a form of ownership and includes both town homes and apartment-type complexes. The models could be improved by separating out the types of unit more finely should such data be available.
10. Approximately 3.6 per cent (200) of observations were deleted for groups of nearby condos in the same development on the same sale date where the transaction price appeared to be for the entire group sale. Excluding these data left 5285 observations.
11. Pre-regression tests were run to identify whether there were multicollinearity problems among the independent variables. *BinaryWD* and *BinaryTOD* had a statistically significant correlation, but at 0.23 for all single-family houses and 0.46 for condos, they were below the standard threshold of concern of ±0.70 (Clark and Hosking, 1986). Pair-wise correlations for variables ranged from a high positive correlation of 0.67 for *Lot* and *LivSqFt* for condos, to -0.34 for *BinaryTOD/DistAmen* for condos, also below the general threshold of concern.
12. For condo complexes, the Assessor's Office assigns a pro-rated proportion of the building footprint to each individual unit. The data are

limited in that no information is available on views, number of floors or building height.

13. Modellers have used numerous variables to represent distance to an LRT station, ranging from straight-line distance to the station, to a series of buffers, network distance based on the street configurations and mathematical transformations of distance such as the reciprocal distance to convey some distance decay (see Parsons Brinkerhoff, 2001, for a detailed summary). The variable used in this study, *BinaryWD*, is a hybrid of network distance and buffering because it includes areas that are within a half-mile walking distance of an LRT station using the pre-existing street network.
14. This binary variable implies that treatment with overlay zoning is dichotomous, an assumption that only holds true if similar geographical settings are considered. For example, a downtown area that already has higher-density development, may not need overlay zoning to stimulate TOD.
15. Freeways have long been considered a potential disamenity in urban areas because of the noise, air pollution and congestion generated by vehicular traffic (Lash, 1965). In some locations within the study area, the freeways are sunken and have noise buffers to mitigate their impact on local communities; in other places, they transect communities. In this particular study, therefore, freeways may be considered a locally unwanted land use in some areas while in others their disamenity is outweighed by the mobility benefits provided to the community. If freeways are considered a benefit, then the expected sign of the coefficient would be negative, indicating that the further a property is from a freeway, the lower the price; if freeways are considered a nuisance, the reverse would be true.
16. Initial model results showed signs of heteroscedasticity. The paper presents results from LIMDEP corrected for heteroscedasticity (Greene, 2002). LIMDEP uses a revised and robust OLS covariance matrix based on White (1978) who developed a consistent estimator of the standard errors under heteroscedasticity. The correction does not change the coefficient estimates, but does change the standard errors and t-ratios.
17. Coefficients for binary variables in models with a semi-logarithmic functional form approximate, but do not translate directly, into elasticities. Following the work of Halvorsen and Palmquist (1980), the approximate influence of the binary variable, βi, on price, $P(H)$ is as follow

$$P(H) = \exp(\beta i) - 1 \quad (3)$$

A more accurate approximation for the estimator was suggested by Kennedy (1981), as follows

$$P(H) = \exp\left(\beta i - \frac{1}{2}\mathrm{VAR}(\beta i)\right) - 1 \quad (4)$$

Estimates for coefficients for the LRT-related binary variables calculated using both Halvorsen and Palmquist's estimation and Kennedy's modification showed little difference.

18. The major difference between this study and that conducted by Knaap *et al.*, 2001, is that they focused on the Blue Line, which was an extension of the system that opened in 1986, rather than the starter segment, which is the case for Phoenix. The major similarity is that the analysis focused on 'pre-service impacts' using data for 1992–96, ahead of 1998 opening.

References

Abbitt, J. W. (1990) *History of transit in the Valley of the Sun: a history of public transportation in Phoenix, Arizona, 1887-1989*. Public Transit Department, Phoenix, AZ.

Al-Mosaind, M. A., Dueker, K. J. and Strathman, J. G. (1995) *Light-rail transit stations and property values: a hedonic price approach*. Transportation Research Board, National Research Council, Washington, DC.

Altshuler, A. and Luberoff, D. (2003) *Mega Projects: The Changing Politics of Urban Public Investment*. Washington, DC: Brookings Institution Press.

ARPA (Arizona Rail Passenger Association) (2006) *History of transportation elections in the Valley of the Sun, 1960–2000* (http://www.azrail.org/trains/transit/transit-elections/).

Belzer, D., Autler, G., Espinosa, J. *et al.* (2003) The transit-oriented development drama and its actors, in: H. Dittmar and G. Ohland (Eds) *The New Transit Town: Best Practices in Transit-oriented Development*, pp. 41–56. Washington, DC: Island Press.

Bertolini, L. and Split, T. (1998) *City on Rails: The Redevelopment of Railway Station Areas*. New York: Routledge.

Bourassa, S. C., Hoesli, M. and Peng, V. S. (2003) Do housing submarkets really matter?, *Journal of Housing Economics*, 12(1), pp. 12–28.

Breznau, S. (2003) The San Jose case study: Ohlone-Chynoweth station, in: H. Dittmar and G. Ohland (Eds) *The New Transit Town: Best Practices in Transit-oriented Development*, pp. 193–210. Washington, DC: Island Press.

Brown, D. G. and Robinson, D. T. (2006) Effects of heterogeneity in residential preferences on an agent-based model of urban sprawl, *Ecology and Society*, 11(1) (online).

Calthorpe, P. (2003) Foreword, in: H. Dittmar and G. Ohland (Eds) *The New Transit Town: Best Practices in Transit-oriented Development*. Washington, DC: Island Press.

Cervero, R. and Duncan, M. (2001) *Transit's added value: effects of light and commuter rail services on commercial land values*. Department of City and Regional Planning, University of California, Berkeley, CA.

Cervero, R. and Kockelman, K. M. (1997) Travel demand and the 3Ds: density, diversity, and design, *Transportation Research Part D*, 3, pp. 199–219.

Chen, H., Rufolo, A. and Dueker, K. J. (1998) Measuring the impact of light rail systems on single-family home values: a hedonic approach with geographic information system application, *Transportation Research Record*, 1617, pp. 38–43.

City of Phoenix, Arizona, Planning Department (2002) *Interim transit-oriented district overlay zoning ordinance*.

City of Phoenix, Arizona, Planning Department (2004) *Downtown Phoenix: a strategic vision and blueprint for the future*.

City of Portland, Oregon (2008) *Portland online: official website for the City of Portland, Oregon* (http://www.portlandonline.com).

City of Tempe, Planning Department (1997) *Apache Boulevard redevelopment plan*.

City of Tempe, Planning Department (2006) *City of Tempe, Arizona, zoning and development code (amended)*.

Clark, W. A. V. and Hosking, P. L. (1986) *Statistical Methods for Geographers*. New York: Wiley.

Cliff, A. D. and Ord, J. K. (1973) *Spatial Autocorrelation*. London: Pion.

Cropper, M. L., Deck, L. B. and McConnell, K. E. (1988) On the choice of functional form for hedonic price functions, *Review of Economics and Statistics*, 70(4), pp. 668–675.

Danielsen, K. A., Lang, R. E. and Fulton, W. (1999) Retracting suburbia: smart growth and the future of housing, *Housing Policy Debate*, 10(3), pp. 513–540.

Dear, M. (1992) Understanding and overcoming the NIMBY syndrome, *Journal of the American Planning Association*, 58(3), pp. 288–300.

Dittmar, H. and Poticha, S. (2003) Defining transit-oriented development: the new regional building block, in: H. Dittmar and G. Ohland (Eds) *The New Transit Town: Best Practices in Transit-oriented Development*, pp. 19–40. Washington, DC: Island Press.

Downs, A. (1992) Remedies that increase residential densities, in: A. Downs (Ed.) *Stuck in Traffic*, ch. 6. Washington, DC: Brookings Institution Press.

Downs, A. (1997) The challenge of our declining big cities, *Housing Policy Debate*, 8(2), pp. 359–408.

Duaney, A., Plater-Zyberk, E. and Speck, J. (2001) *Suburban Nation: The Rise and Sprawl of the American Dream*. New York: North Point Press.

Duncan, M. (2008) Comparing rail transit capitalization benefits for single family and condominium units in San Diego, CA, *Transportation Research Record*, 2067, pp. 120–130.

Ewing, R., Bartholomew, K., Winkelman, S. *et al.* (2008) *Growing cooler: the evidence on urban development and climate change*. Urban Land Institute, Washington, DC.

Farris, J. T. (2001) The barriers to using urban infill development to achieve smart growth, *Housing Policy Debate*, 12(1), pp. 1–30.

Feigon, S., Hoyt, D. and Ohland, G. (2003) The Atlanta case study: Lindbergh City Center, in: H. Dittmar and G. Ohland (Eds) *The New Transit Town: Best Practices in Transit-oriented Development*, pp. 175–192. Washington, DC: Island Press.

Fernandez, L. E., Brown, D. G., Marans, R. W. and Nassauer, J. I. (2005) Characterizing location preferences in an exurban population: implications for agent-based modeling, *Environment and Planning B*, 32(6), pp. 799–820.

Fik, T. J., Ling, D. C. and Mulligan, G. F. (2003) Modeling spatial variation in housing prices: a variable interaction approach, *Real Estate Economics*, 31(4), pp. 623–646.

Fujita, M. (1989) *Urban Economic Theory: Land Use and City Size*. Cambridge: Cambridge University Press.

Gober, P. (2005) *Metropolitan Phoenix: Place-making and Community-building in the Desert*. Philadelphia, PA: University of Pennsylvania Press.

Gober, P. and Burns, E. K. (2002) The size and shape of Phoenix's urban fringe, *Journal of Planning Education and Research*, 21(4), pp. 379–390.

Goodman, A. C. and Thibodeau, T. G. (1998) Housing market segmentation, *Journal of Housing Economics*, 7(2), pp. 121–143.

Greene, W. H. (2002) *LIMDEP Version 8.0, Manual*. Plainview, NY: Econometric Software.

Halvorsen, R. and Palmquist, R. B. (1980) The interpretation of dummy variables in semi-logarithmic equations, *American Economic Review*, 70, pp. 474–475.

Hess, D. B. and Lombardi, P. A. (2004) Policy support for and barriers to transit-oriented development in the inner city: literature review, *Transportation Research Record*, 1887, pp. 26–33.

Kahn, M. E. (2007) Gentrification trends in new transit-oriented communities: evidence from 14 cities that expanded and built rail transit systems, *Real Estate Economics*, 35(2), pp. 155–182.

Kennedy, P. (1981) Estimation with correctly interpreted dummay variables in semilogarithmic equations, *American Economic Review*, 71, p. 801.

Knaap, G. J., Ding, C. R. and Hopkins, L. D. (2001) Do plans matter? The effects of light rail plans on land values in station areas, *Journal of Planning Education and Research*, 21(1), pp. 32–39.

Lake, R. W. (1993) Planners alchemy transforming NIMBY to YIMBY, *Journal of the American Planning Association*, 59(1), pp. 87–93.

Landis, J., Cervero, R., Guhathukurta, S. *et al.* (1995) *Rail transit investments, real estate values, and land use change: a comparative analysis of five California rail transit systems*. Monograph 48, Institute of Urban and Regional Development Studies, University of California, Berkeley, CA.

Lang, R. E. and Danielsen, K. A. (2005) Cities and the creative class, *Journal of The American Planning Association*, 71(2), pp. 203–206.

Lang, R. E., Hughes, J. W. and Danielsen, K. A. (1997) Targeting the suburban urbanites: marketing central-city housing, *Housing Policy Debate*, 8(2), pp. 437–470.

Lash, M. (1965) *Community conflict and highway planning*. Transportation Research Board, Washington, DC.

Leach, D. (2003) The Arlington County case study: Rosslyn–Ballston corridor, in: H. Dittmar and G. Ohland (Eds) *The New Transit Town: Best Practices in Transit-oriented Development*, pp. 131–154. Washington, DC: Island Press.

Levine, J. and Frank, L. D. (2007) Transportation and land-use preferences and residents' neighborhood choices: the sufficiency of compact development in the Atlanta region, *Transportation*, 34(2), pp. 255–274.

Levine, J. and Inam, A. (2004) The market for transportation–land use integration: do developers want smarter growth than regulations allow?, *Transportation*, 31(4), pp. 409–427.

MAG (Maricopa Association of Governments) (2003) *Growing smarter implementation project best practices: transit-oriented development*. MAG, Phoenix, AZ.

MAG (2007) *Regional transportation plan*. MAG, Phoenix, AZ.

Matthews, J. W. and Turnbull, G. K. (2007) Neighborhood street layout and property value: the interaction of accessibility and land use mix, *Journal of Real Estate Finance and Economics*, 35(2), pp. 111–141.

Michaels, R. G. and Smith, V. K. (1990) Market-segmentation and valuing amenities with hedonic models: the case of hazardous-waste sites, *Journal of Urban Economics*, 28(2), pp. 223–242.

Muller, J. C. (1977) Map gridding and cartographic errors: a recurrent argument, *Cartographica*, 14(2), pp. 152–167.

Nelson, A. C. (1999) Transit stations and commercial property values: a case study with policy and land-use implications, *Journal of Public Transportation*, 2(3), pp. 77–95.

Ohland, G. (2003a) The Dallas case study: Mockingbird Station and Addison Circle, in: H. Dittmar and G. Ohland (Eds) *The New Transit Town: Best*

Practices in Transit-oriented Development, pp. 155–174. Washington, DC: Island Press.

Ohland, G. (2003b) The San Diego case study: Barrio Logan's Mercado project, in: H. Dittmar and G. Ohland (Eds) *The New Transit Town: Best Practices in Transit-oriented Development*, pp. 211–230. Washington, DC: Island Press.

Parsons Brinkerhoff (2001) *The effect of rail transit on property values: a summary of studies*. Research carried out for Project 21439S, Task 7 (draft), NEORail II, Cleveland, OH, Parsons Brinkerhoff, New York.

Paternoster, R., Brame, R., Mazerolle, P. and Piquero, A. (1998) Using the correct statistical test for the quality of regression coefficients, *Criminology*, 36(4), pp. 859–866.

Pendall, R. (1999) Opposition to housing: NIMBY and beyond, *Urban Affairs Review*, 35(1), pp. 112–136.

Plaut, P. O. and Boarnet, M. G. (2003) New urbanism and the value of neighborhood design, *Journal of Architectural and Planning Research*, 20(3), pp. 254–265.

Renne, J. L. and Wells, J. S. (2005) *Transit-oriented development: developing a strategy to measure success*. National Cooperative Highway Research Project No. 2065(5), Transportation Research Board, Washington, DC.

Sohmer, R. R. and Lang, R. E. (2001) *Downtown rebound*. Fannie Mae Foundation and Brookings Institution, Washington, DC.

TCRP (Transit-Cooperative Research Program) (1997) *The role of transit in creating livable metropolitan communities*. TCRP, Washington, DC.

TCRP (2002) *Transit-oriented development and joint development in the United States: a literature review*. TCRP, Washington, DC.

TCRP (2004) *Transit-oriented development in the United States: experiences, challenges, and prospects*. TCRP, Washington, DC.

Tu, C. C. and Eppli, M. J. (1999) Valuing new urbanism: the case of Kentlands, *Real Estate Economics*, 27(3), pp. 425–451.

White, H. (1978) A heteroscedasticity consistent covariance matrix and a direct test for heteroscedasticity, *Econometrica*, 46, pp. 817–838.