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THE CURSE OF STUDENT HOUSING: EVIDENCE FROM WOLFVILLE, NOVA SCOTIA

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Abstract.
Wolfville is a small town in Nova Scotia, known for its picturesque Victorian houses and as home to Acadia University. Acadia University is the prime economic driver, with students almost doubling the town's population when classes are in session. The large student population translates into student housing being an important land use in Wolfville, with several neighbourhoods well described as 'student ghettos'. Rental income from students is an important income source for many property owners, while the challenges of living near student housing are also well known. Student housing ranges from rooms and small apartments in single family homes to large converted homes with multiple units, and town zoning largely determines and/or reflects the location of these different land uses.

The town lies on a north facing hill, with an important provincial highway marking the southern boundary of the town. Provincial plans include twinning the highway, which would likely increase traffic volumes and speeds, and increase noise levels in the town. While business and property owners are generally in favour of upgrading the highway, doing so does carry a negative external cost which should be considered in assessing the full costs and benefits of twinning the highway. This research project aims to quantify this negative externality and thereby contribute to identifying the best approach to this highway expansion.

Twenty-four hour noise level measurements were made at 28 different sites throughout the town. A quadratic spatial regression was used to interpolate sound levels for each of 146 property transactions in Wolfville between 1998 and 2003. Listings data were combined with from the street observations to build a table of property characteristics. These were included in a square root regression to predict property prices.

Common dependent variables generated the expected signs. Average sound level did not enter significantly, but peak sound level did. Since the background noise level is relatively low, the infrequent peak events are a more appropriate measure of the noise that people are adverse to. A one decibel increase in peak sound level reduces the average property price by about $2,700, suggesting that for the town as a whole, twinning the highway would generate a significant negative externality that offsets some of the expected benefits. Zoning classification explained the largest share of property price variation, likely capturing the negative externality generated by student housing. Thus, while the income opportunity generated by offering rental accommodation is important in the town, Wolfville home buyers are willing to pay a substantial premium to not live in neighbourhoods dominated by student housing. While these results largely confirm previous work, whether student tenant welfare is increased by such segregation remains to be addressed.

Key Words: Student housing, hedonic property valuation, noise pollution.

JEL Codes: Q51, Q53, R14, R31, R52.

Résumé. Les difficultés des logements étudiants : Un témoignage de Wolfville, Nouvelle Écosse
Wolfville est une petite ville en Nouvelle-Écosse, connu pour ses maisons victoriennes pittoresques et pour son Acadia University. Acadia University représente le moteur économique principal, avec les étudiants contribuant à pratiquement doubler la population de la ville quand les cours commencent. Cette grande population étudiante veut dire que les logements pour les étudiants constituent une importante utilisation du sol à Wolfville, et plusieurs quartiers sont bien décrits en tant que « ghettos étudiants ». Le revenu provenant de la location de logements aux étudiants représentent une importante source de revenue pour de nombreux propriétaires de logements, tandis que les défis de vivre à proximité des logements étudiants sont bien connus. Les logements des étudiants variant entre de chambres individuelles et de petits appartements dans des maisons unifamiliales à des grandes maisons converties avec des logements multiples, et c'est le zonage municipal qui détermine et/ou reflète en grande mesure la localisation de ces différentes utilisations du sol.

La ville est situé sur une colline donnant vers la nord, avec une importante route provinciale qui démarque la limite sud de la ville. Les plans de la Province incluent le doublement de cette route, qui aurait comme effet en toute probabilité une augmentation du volume de circulation et de la vitesse, et une augmentation des volumes de bruit dans la ville. Bien que les propriétaires des commerces et des propriétaires soient en général en faveur de l'amélioration de cette route, elle comporte des coûts d'externalités négatives qui devraient être pris en considération dans l'évaluation des coûts et des bénéfices totaux de ce doublement de la route. Le but de ce projet de recherché est de quantifier cette externalité négative et par là de contribuer à l'identification de la meilleure approche à entreprendre pour cette expansion de route.

Des mesures du niveau de bruit sur 24 heures furent entreprises pour 28 sites différents à travers la ville. Une régression quadratique fut utilisé afin d'interpoler les niveaux de son pour chacune des 146 transactions de propriété dans Wolfville entre 1998 et 2003. Des données annonçant les ventes furent combines avec des observations directes dans le rue afin de construire un tableau des caractéristiques des propriétés. Celles-ci furent intégrées dans une régression à racine carré afin de prédire les prix des propriétés.

Des variables dépendantes communes ont généré les signes attendues. Le niveau moyen de son n'étaient pas significatives, mais le niveau de son maximum l'était. Étant donné que le niveau de son de l'arrière-plan est relativement bas, les évènements extrêmes périodiques représentent une mesure plus appropriée du bruit auquel les gens sont dérangés. Une augmentation d'un décibel du niveau maximum de son réduit le prix moyen des propriétés d'environ 2.700$.ce qui suggère que pour la ville en général le doublement de la route génèrerait une externalité négative significative qui réduirait certaines des bénéfices attendues. La classification du zonage expliquait la plus grande proportion de la variation du prix des propriétés, ce qui reflète probablement l'externalité négative créée par les logements étudiants. Donc, bien que l'opportunité de revenue créée par l'offre de logement en location soit importante dans la ville, les acheteurs de logements à Wolfville sont prêts à payer un premium important pour ne pas vivre dans des quartiers dominés par le logement étudiant. Bien que ces résultats confirment en général ceux des recherché antérieures, la question de l'amélioration du bien-être étudiant par une telle ségrégation reste ouverte.

Mots clés : Logement étudiant, évaluation hédonique de propriété, pollution sonore.

Codes JEL : Q51, Q53, R14, R31, R52.

Introduction

Wolfville lies approximately 100 kilometers west-northwest of Halifax, Nova Scotia. Its principle economic driver is Acadia University, with tourism playing an important role during the summer months. The tourist appeal of Wolfville is partly due to the many stylish and historic homes lining its main streets. The town sits on the northern slope of a low ridge, affording many homes an attractive view of the Minas Basin. However, a major provincial highway, Highway 101, runs along the southern edge of town, producing noise that is audible in the open fields north of the town. Highway 101 connects area residents to the provincial capital Halifax, the economic hub of the provincial economy. There is considerable political pressure to expand the highway, which is expected to further increase trips from the city and boost local economic activity. However, any increase in traffic will also create local costs, one of which is noise pollution. This project's initial motivation was to estimate this cost.

Hedonic property value pricing, an empirical implementation of the Lancaster characteristics model of a good (Lancaster, 1966), was first popularised by Rosen (1974). Home purchasers buy a bundle of characteristics – such as lot size, house area, type of zoning, distance from amenities, environmental factors and neighbourhood effects – when purchasing a house. With sufficient variation in these characteristics across the housing market, they can be individually priced.

Anecdotally, the adverse effect on property values of negative externalities such as noise level is well known. These anecdotes are reflected in the literature. Nelson (2004) reviews a number of hedonic pricing studies of noise pollution conducted in the 1970s. He identifies three key assumptions that underlay this approach. First, that there is sufficient turnover in the market so that buyers have the ‘freedom to move’ in response to differences in sound level. Second, there must be sufficient variation in sound level across the sample of houses. Third, it must be possible to measure sound levels at an appropriate resolution for successful impact estimation. For the reviewed work, a one decibel (dB) increase in sound levels leads to a 0.40% decline in the price of an average house. A more recent review (Navrud, 2002) surveys studies using hedonic pricing, contingent valuation, choice experiment, and conjoint analysis methods finds a noise discount of between 0.08% and 2.30% of the property price per decibel. Translating the capitalised cost into an annual cost, noise costs fall between 2 and 99 euros per decibel per household per year.

Asymmetric information and neighbourhood effects can confound hedonic pricing of externalities. The former would be evidenced by higher turnover rates where buyers discover the externality after purchasing the home, and subsequently try to sell it. The latter is detected using spatial autocorrelation tests. Wilhelmsson (2000) examines the impact of traffic noise on the value of single family homes in Sweden, paying particular attention to the potential for asymmetric information effects. No statistical support is found for differing turnover rates, suggesting that asymmetric information with respect to noise is not an issue in the sample. The noise discount is 0.6% per decibel. Theebe (2004) uses spatial autocorrelation techniques to look for a relationship between noise levels and property values in the Netherlands. Some weak evidence is found for larger discounts in high income areas. The implied per decibel discount is around 0.4%. Proxies for noise level, such as traffic density, have been used (Hughes and Sirmans, 1992). While the expected discount is found, and typically highly significant, it is unclear if traffic noise, accident risk, pollution, or some other factor related to traffic level is driving the decline in property values.

Airport noise impacts on property values have received considerable attention. Lipscomb (2003) considers the impact of airport noise, using sound level contours reported by a local airport, on property values in a small city near Atlanta, Georgia. In this case, no influence of noise level is found. This is attributed to the fact that many households in this city rely on employment at the airport, so that the advantage of proximity to work offsets the impact of noise pollution. A meta-analysis of the relationship between airport noise and property values conducted by Nelson (2004) finds an average impact on selling prices of 0.58% per decibel, with the Canadian subset of the sample generating noise discounts of between 0.8% and 0.9% per decibel. In contrast to Lipscomb, Nelson is unable to measure a benefit for proximity to the airport. An income effect is suggested, where the willingness to pay for quiet is increasing in income.

Zoning ordinances can be used to separate land uses according to externalities generated or experienced. For example, locating commercial activities near busy roadways both facilitates access to the businesses, and separates residential property from any associated externalities. Likewise, zoning low income housing where negative externalities are more prevalent separates higher income residents from both the externalities directly related to building design and density, and any additional externalities (such as crime) associated with low income housing. It may also reduce the cost of building low income housing by reducing the land costs relative to other potential sites. Crecine et al (1967) attempted to relate zoning classifications with of a number of neighbourhood externalities through the influence on property values. For single family homes, no consistent effect was found. Maser et al (1977) examine the impact of both zoning and a number of externalities on property values in Monroe County, New York. Zoning designation is not found to affect property values, while several externalities (positive near water, positive near park, negative near airport) do. The authors conclude that externalities are being appropriately priced by the market, and zoning restrictions are therefore not contributing to an outcome any different from the market outcome. Pogodzinski and Sass (1991) argue that zoning restrictions limit buyer choice and supplier offerings, and thereby impact on the pricing equation parameters. They find that interactions between zoning restrictions and specific characteristics can be significant, and that the effect of zoning restrictions estimated absent these interactions can be biased. Based on their analysis of Santa Clara County, zoning restrictions are found to significantly affect the pricing equation.

Stull (1975) used aerial photos to characterise land use for communities within the Boston Metropolitan Area. The fact that the price of single family homes was negatively affected by increasing the proportion of most other land uses was taken as supporting the idea that zoning can protect the value of single family homes. Asabere and Huffman (1997) focus on the hierarchical nature of many zoning rules, which progressively relax the restrictions on land use. For example, areas zoned for multi-family do not forbid single family homes, but areas zoned for single family do forbid multi-family residences. For single family homes in central Philadelphia, there is a price discount of more than 15% if the home is located in a zone permitting apartments compared to one that does not. In contrast, for Santa Clara County, California, Cervero and Duncan (2004) find a positive price premium for mixed use neighbourhoods relative to single family neighbourhoods. However, Santa Clara is a rapidly growing area with a relative shortage of affordable housing, so that the price of single family homes may be capitalising the development potential.

Zoning has also served as a tool for excluding undesired groups. Crecine et al (1967) include the proportion of non-whites in their various regressions, and find that the effect of greater heterogeneity is generally negative, with similar results reported more recently by Cervero and Duncan (2004). Maser et al (1977) include percent African American (the term 'Negro' is used in the paper itself) in their regressions, and find that the effect on prices is negative and significant. Along another segregation dimension, Wang et al (1991) examine how the proximity of rental properties affects sale prices. They find that owner occupied homes sell for more than rented homes, that proximity to rental homes reduces price, and that the amount of rental homes in a neighbourhood also reduces price. Their results are consistent with two effects, a tendency of landlords to invest less in maintenance than owner occupants, and a desire for higher income owners to segregate themselves from lower income renters. In a similar vein, Asabere and Huffman (1997) include unemployment, and finds that homes in neighbourhoods with higher unemployment rates sell for less.

As a study site for examining environmental externalities such as sound and view, and the impact of student housing on property values, Wolfville provides several attractive characteristics. As a university town with no major industrial activities, variety of land use is relatively limited. With respect to the assumptions listed by Nelson (1982), the relatively high income means that budget constraints are likely to have a limited impact on house choice, while the sound data collected shows both a relatively large range and spatial variation, with interpolation techniques developing 'reasonable' estimates for each property. The impact of noise level in Wolfville is also less likely to be confounded by access issues, as access to highway 101 is not available within the town, and no major local noise generator (excepting students) is an important employer. The absence of significant employers beyond Acadia University and its importance as a destination for a large fraction of local commuting travel limits the number of confounding proximity effects. Incomplete information on the part of buyers – particularly new faculty moving to Wolfville from far away – may be a problem. However, highways are generally well known as noise sources, and an understanding of student housing issues is likely understood by faculty moving to the area, so this is unlikely to be a large issue. Further, the relatively high income makes the transactions costs associated with relocating within the town less of an issue in Wolfville, compared to other towns. Wolfville, therefore, appears to be an ideal location to measure the impact on house prices of noise pollution, and we would also expect the influence of different housing types to be significant.

Data

Wolfville is considerably different from provincial averages along many demographic dimensions. Many of these differences are consistent with a university town, which is a mixture of highly educated and well paid faculty, together with students with relatively limited means and little reason to invest in long term housing. Some key features, including income and earnings, household ownership, education, and commuting mode, are highlighted in Table 1. Among those who hold down a full time job, average earnings are 15% above the provincial average. However, the median income is 11% below the provincial median. Home ownership is well below the provincial average, with 52% of dwellings being rented. The portion of the population with a university degree, diploma, or certificate is between two and three times the provincial average, depending on age group. For commuting, one quarter of the working population commutes on foot or bicycle.

TABLE 1 Selected Demographic Characteristics for Wolfville, Nova Scotia

	Wolfville		Nova Scotia	
	Total	Percent	Total	Percent
Population	3,658		908,007	
Median Income	16,663	89	18,735	100
Median Age	39.3		38.8	
Average Earnings	43,583	115	37,872	100
Private households	1,615	100	360,020	100
Rented dwellings	840	52	103,305	29
Owner occupied	775	48	252,150	29
Percent of pop with degree, diploma, ...				
Aged 20-34		38.7		22.8
Aged 35-44		55.6		19.6
Aged 45-64		59.0		18.1
Occupation - total	1,780	100	442,420	100
Social science, education, ...	450	25	33,375	8
Art, culture, recreation, and sport	165	9	11,125	3
Total trips to work	1,470	100	373,045	100
Trips by car, truck, or van	1,045	71	280,365	85
Walked or bicycled	365	25	33,130	9

Source: Statistics Canada (2001)

During the summer of 2003, sound levels were recorded for about 22 hours at 28 sites in the study area. A Larson-Davis Model 712 sound meter was secured in the back yards of homes volunteered by Acadia employees. Given that people enjoy their back yard more for social functions and recreation, this was seen as the appropriate observation site. Figure 1 shows the location of the sound observations, relative to the major roads in the community. At each site, the data logger recorded hourly measurements for about 22 hours. All intervals shorter than 3600 seconds (one hour) were dropped, as well as the observations with the two highest sound levels recorded, to remove noise from handling the data logger, and extreme events such as lawn mowing and heavy down-pours.

Sound level data is summarised in Table 2. The data logger records the exponentially smoothed sound pressure for one second intervals. Functionally, the raw data recorded is

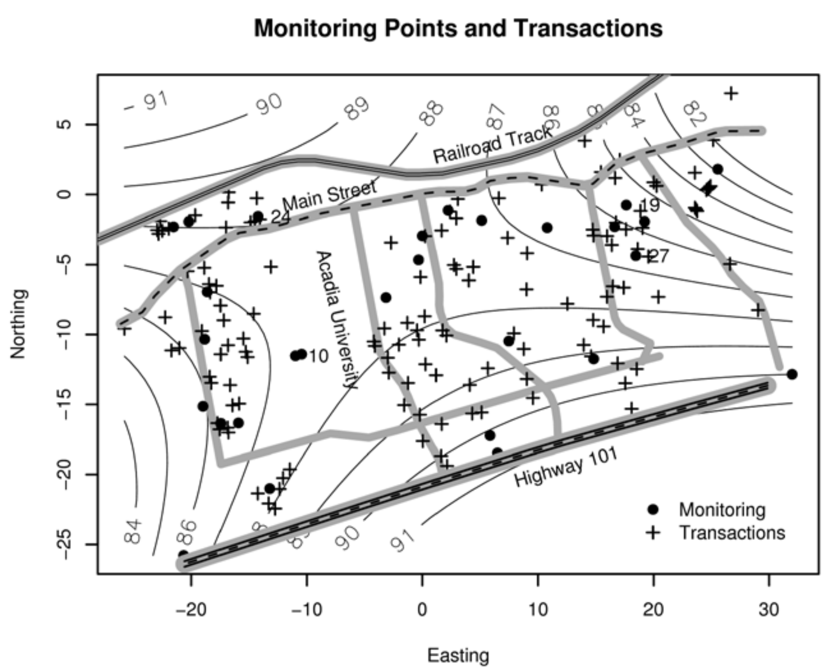
$$L_p(t) = 10\log_{10}\left[(1/T)\int_{t_s}^{t} p(\xi)^2 e^{-(t-\xi)/T}\, d\xi / p_0^2\right]$$

where the reference level p_0 is $20\mu Pa$ with $t_s = t - T$ and $T = 1$ second. L_p is a decibel measure (dB), a unit-less measure of the sound pressure relative to $20\mu Pa$, the lower limit of human hearing. For each one hour block, the data logger calculates the peak, or highest, recorded L_p, as well as the equivalent constant sound level

$$L_{eq} = 10\log_{10}\left[\int_{T_1}^{T_2} p(t)^2\, dt/p_0^2 (T_2 - T_1)\right] \tag{1}$$

where $T_2 - T_1$ is one hour or 3600 seconds. To average for other intervals and construct interpolations, the decibel measures were converted to a sound pressure levels, used for averaging or interpolating, and then converted back to decibels.

FIGURE 1 Locations of Monitoring Sites and Properties Traded, with Peak Sound Level Profile



Note: Numbers identify monitoring sites mentioned in Table 1. Contours map a quadratic interpolated of the L_{peak} sound level.

The L_{peak} and L_{eq} observations were used to interpolate a sound profile for Wolfville, with the one observation made near the highway duplicated and located at each end of the town, to anchor the interpolation. Four methods were used – OLS forecasting on nearest neighbours, simple average and inverse distance weighted average, together with polynomial surface estimation – on all points simultaneously. Based on fit in the regression model and consistency of the sound contours with local perceptions, a quadratic polynomial surface was used (Figure 1).

Listings data together with sales price for properties traded between July 1998 and June 2003 were provided by a local real estate agent. See Tables 3 and 4 for summary statistics. Each identifiable property was located and visited for a ‘from the street ranking’ of criteria such as presence of a garage, paved driveway, mature trees and a view of the Minas Basin. Due to missing observations, 26 of the 149 property transaction observations were dropped from the final analysis. Between the years 1998 and 2003, with no adjustment for inflation, the average price for a home was $136,770. Wolfville is a historic Canadian town, which is evidenced by the fact that among the sold homes, the average age was 45.3 years, with one home of 176 years old traded.

TABLE 2 Summary of Sound Level Observations

Averaging	Site	No.		Mean	St. Dev.	Min.	Max.
All	Average	-	L_{eq}	47.6	6.16	35.3	67.9
			Peak	82.8	9.40	61.2	110.2
	Minimum	10	L_{eq}	41.8	2.39	38.0	46.1
			Peak	80.1	8.62	65.5	101.7
	Maximum	Hwy	L_{eq}	56.4	2.80	51.7	60.1
			Peak	89.7	5.21	82.8	102.8
Day	Average	-	L_{eq}	51.2	6.22	40.4	79.8
			Peak	87.6	9.50	65.5	113.7
	Minimum	27	L_{eq}	44.3	2.23	38.9	48.2
			Peak	78.9	7.83	71.2	99.7
	Maximum	24	L_{eq}	60.8	7.33	49.8	78.5
			Peak	88.4	11.78	78.9	129.8
Night	Average	-	L_{eq}	44.5	6.06	35.3	68.0
			Peak	78.6	9.68	61.2	111.8
	Minimum	19	L_{eq}	38.5	2.25	36.0	42.5
			Peak	76.0	4.58	70.7	80.7
	Maximum	Hwy	L_{eq}	54.2	2.36	51.7	58.7
			Peak	87.9	3.54	82.8	95.6

Note: Data were recorded at 28 sites, 27 in residential yards and one near the highway. The No. column reports identifiers for map sites (Figure 1).

The importance of rental accommodation is evident in the data. In the feature set, this shows up as homes having large numbers of bathrooms (up to 4 full bathrooms, 5 half bathrooms) and bedrooms (up to 7). It also shows up in the zoning classification, where 105 of the 149 properties traded were zoned to permit some form of rental accommodation, and 67 were zoned for multiple units.

TABLE 3 Ratio Scale and Dummy Variables, with Descriptive Statistics

Variable	Description	Mean	Median	Min	Max
	Price at which home actually sold	136,770	123,500	28,500	399,000
AGE	Age of home	45.3	25	0	176
FLOOR	Area of living space, in m^2	148.0	127.7	53.1	447.6
LOT	Area of lot which house occupies, in m^2	1,119.0	958.1	0.0	12,100.0
FBATH	Number of bathrooms with a full bath	1.67	2	1	4
HBATH	Number of bathrooms without a full bath	0.36	0	0	5
CENTER	Straight line distance to town center, in *km*	0.607	0.881	0.134	1.510
MAIN	Shortest distance to Main Street, in *km*	0.317	0.375	0.978	0.024
ACADIA	Straight line distance to center of campus, in *km*	0.688	0.853	0.211	1.906
BEDS	Number of bedrooms	3.34	3	1	7
	Number of days property on market	124.2	128.2	0	596
	Measurement of average sound level, *db*	47.18	46.09	40.99	54.65
PEAK	Measurement of peak sound level, *db*	87.25	87.56	79.62	90.55
WELL	Is water source a well (well = 1)?	0.02	Town	0	1
	Semi-detached or single family (single = 1)?	0.95	Single	0	1
	One or two stories (two stories = 1)?	0.31	One	0	1
	View of the Minas Basin (yes = 1)?	0.21	None	0	1
	View of the highway (yes = 1)?	0.05	None	0	1
HISTORIC	Is property designated historic (no = 1)?	0.02	Not	0	1
	Is driveway paved (yes = 1)?	0.76	Paved	0	1

Note: Variable names are as for those included in reported regression results.

TABLE 4 Categorical Variables

Description	Categories				
	Electric	Oil	Wood	Other	
Heating Source	54	75	17	3	
	R-1	R-1A	R-2/4	R-8	RCDD
Zoning Classification	44	38	39	15	13
	None	Free	Attached		
Type of Garage	92	21	27		
	Single	Condo			
Single Family or Condominium	129	20			
	None	Young	Mature		
Trees	25	62	53		
	Freehold	LeaseHold	Other		
Title to Property	127	2	20		
	1998	1999	2000	2001	2002
Year	12	32	30	35	40
	Q1	Q2	Q3	Q4	
Quarter	32	54	36	27	

Note: In the regression, dummies are included for each possible value of categorical variable.

Results and Discussion

To allow some flexibility in functional form, (see Cropper et al, 1988), a Box-Cox functional form is used. Both linear and logarithmic are rejected with $\alpha = 0.05$, but square root cannot be rejected. The regressions were run with both full transformation and transformation of the dependent variable only, with the latter showing a slightly better fit. The independent variables were therefore not transformed.

In general, the explanatory power of all three functional forms is high. Regression diagnostics are reported in Table 5, for two regressions of each functional form. When zoning is not include, the R^2 values range between 0.842 and 0.885. With zoning classifications included, the R^2 values range from 0.892 to 0.912. As a check for specification errors, the Durbin-Watson statistic is reported. It's values do not suggest a problem. The Breusch-Pagen test for heteroscedasticity is significant for the log-lin and square root-lin versions of the model when zoning is included, but insignificant for the others. For completeness, White's (White, 1980) heteroscedasticity corrected covariance estimated P values are reported as well as the the conventionally calculated P values. The residuals were also tested for spatial correlation by calculating Moran's I (Moran, 1948; Anselin, 1988; Anselin and Bera, 1998), a spatial analog to the Durbin-Watson statistic, using all the data, with inverse neighbour distances as weights. Square root and squared inverse distances were also tried, as well as restricting the set of neighbors to those within smaller radii. For none of these was significance found.

TABLE 5 Regression Diagnostics

	Linear		Logarithmic		Square Root	
	no Z	with Z	no Z	with Z	no Z	with Z
R^2	0.885	0.912	0.842	0.892	0.874	0.911
F	25.830	29.235	17.952	23.223	23.235	28.683
P_F	0.000	0.000	0.000	0.000	0.000	0.000
df	94.000	90.000	94.000	90.000	94.000	90.000
Durbin-Watson	1.923	2.166	1.808	2.196	1.871	2.208
P_{DW}	0.200	0.640	0.069	0.701	0.129	0.725
Breusch-Pagen	25.098	39.757	28.054	53.495	23.469	56.834
P_{BP}	0.623	0.163	0.462	0.010	0.709	0.004
Moran's I	−0.004	−0.019	0.002	−0.016	−0.001	−0.018
P_I	0.535	0.069	0.101	0.175	0.235	0.088

Regression results for the square root model are reported in Table 6. The variables fall into three general categories: household characteristics, neighbourhood or amenity values, and nuisance variables. Household characteristics include age, floor space, lot size, number of bathrooms with a full bath, number of bathrooms without a full bath, number of bedrooms, household water supplied by a well, source of heat (electric, oil, wood, or other), and a dummy for historic designation. All but age, water source, and historic designation are expected to enter positively. Age is typically found to have a negative sign. A private water source requires more management effort and may be more costly to operate, and historic designation limits uses for the property. Heat source is expected to be positive, as the base case is electric, which during the study period was the most costly method of heating a home. In all cases, quadratic terms are expected to have the opposite sign to their linear complement, reflecting a diminishing marginal effect.

Neighbourhood characteristics include distance to centre of town, distance to centre of Acadia campus, perpendicular distance from Main Street, presence of a clear view, presence of an obstructed view, peak sound level, as taken from estimated sound profile, and dummy variables for zoning classification. The distance variables are all expected to be negative, as these are important destinations. Presence of a view is expected to be positive, with a clear view generating a larger impact than an obstructed view. Peak sound level is expected to be negative, with its square positive. Finally, from a naive perspective, zoning codes allowing rentals are expected to be positive, as they provide the owner additional revenue generating opportunities. However, as found by Asabere and Huffman (1997), it may work the other way.

Finally, dummy variables for year and quarter are included to capture seasonal effects and the price trend. Property taxes are not included. The tax rate is uniform in the town, and based on the assessed value. To the extent that the latter is correlated with the true property value, taxes will add nothing, and may introduce endogeneity issues.

TABLE 6 Regression Results

	With Zoning			Without Zoning		
Factor	β	P_{Tr}	P_H	β	P_{Tr}	P_H
(Intercept)	−421.2	0.941	0.485	−11844	0.039	0.062
AGE	−1.029	0.000	0.015	−1.284	0.000	0.008
AGE^2	0.008	0.001	0.041	0.008	0.001	0.055
FLOOR (m^2)	1.113	0.000	0.009	1.076	0.000	0.008
$FLOOR^2$ (m^2)	-0.001	0.004	0.110	-0.001	0.008	0.103
LOT (m^2)	0.026	0.012	0.100	0.019	0.003	0.250
LOT^2 (m^2)	-0.000	0.420	0.445	-0.000	.124	0.459
Full Baths (FBATH)	31.317	0.000	0.000	37.140	0.000	0.000
Half Baths (HBATH)	18.561	0.004	0.121	22.111	0.003	0.066
Bedrooms (BEDS)	−2.811	0.490	0.311	−2.107	0.647	0.361
WELL	−5.838	0.795	0.384	−31.878	0.212	0.072
Heat: OIL	6.079	0.485	0.297	14.554	0.126	0.127
Heat: OTHER	43.609	0.072	0.325	36.692	0.187	0.330
Heat: WOOD	3.661	0.757	0.405	16.186	0.211	0.147
HISTORIC	46.487	0.070	0.296	51.780	0.079	0.255
to town CENTRE (km)	0.002	0.628	0.352	0.003	0.456	0.293
to ACADIA (km)	−1.328	0.015	0.022	−1.249	0.038	0.049
to MAIN Street (km)	−3.421	0.005	0.007	−2.082	0.065	0.051
CLEAR view	−5.839	0.507	0.331	−2.294	0.818	0.433
Obstructed view (OBSTRUCT)	−13.465	0.077	0.073	−10.528	0.227	0.154
PEAK (dB)	8.551	0.949	0.487	279.518	0.037	0.059
$PEAK^2$ (dB)	−0.008	0.992	0.498	−1.621	0.037	0.059
Zone: R-1A	−26.034	0.007	0.023			
Zone: R-2/4	−58.668	0.000	0.000			
Zone: R-8	−14.244	0.566	0.310			
Zone: RCDD	−57.010	0.009	0.002			
Year: 1999	14.105	0.264	0.167	19.056	0.193	0.154
Year: 2000	30.035	0.014	0.008	37.184	0.009	0.010
Year: 2001	50.444	0.000	0.000	59.134	0.000	0.001
Year: 2002	50.210	0.000	0.002	59.300	0.000	0.002
Quarter: Q2	7.415	0.416	0.245	6.042	0.564	0.318
Quarter: Q3	1.768	0.852	0.443	0.559	0.959	0.483
Quarter: Q4	10.100	0.376	0.278	2.108	0.870	0.453

Note: Square root of selling price as dependent variable. Results are presented for regressions with and without zoning classifications. P_{Tr} significance levels are calculated using traditional standard errors, while P_H are calculated using standard errors from a heteroscedasticity corrected covariance matrix (HCCM).

Most of the regression results are consistent with expectations. In all cases where quadratic terms are added, the expected diminishing effect is present. Among household characteristics, AGE and FLOOR, together with FBATH stand out. Somewhat less strong in terms of P value are LOT and the HBATH. In particular, these variables loose significance at $\alpha = 0.05$ when the HCCM adjustment is made. Among variables significant at $\alpha = 0.10$, the OTHER stands out. There are only a few observations in this category, with one being a geothermal heat exchange unit. This equipment can substantially reduce heating costs. HISTORIC is also significant at $\alpha = 0.10$, with a sign opposite to that expected. Since Wolfville is widely known as a historic community, perhaps those choosing to purchase property in Wolfville value this characteristic, in spite of the restrictions imposed. Of the remaining variables, WELL has the expected sign while BEDS does not. Perhaps more bedrooms without more floor space is not that valuable.

Among the neighbourhood characteristics, ACADIA and MAIN have the expected signs. Zoning classifications R-1A, R-2/4 and RCCD are significant and negative. As in Asabere and Huffman (1997) hierarchical zoning case, this may signal that those buying a single family home are willing to pay a premium to segregate themselves from rental tenants. PEAK is significant when zoning is not included, though with an unexpected sign. However, since the average value of L_{peak} is above 80 dB, the marginal impact at the mean is as expected. The fact that sound level becomes insignificant when zoning is included suggests that zoning is grouping homes into categories experiencing similar noise levels. CLEAR and OBSTRUCT are insignificant, suggesting that some people's emphasis on view as a selling factor may be overdone.

For the nuisance variables, the year and quarter dummy variables capture effects as expected, though only the increasing trend in prices is significant. Parameter estimates on the seasonal dummies do show that on average winter quarter prices are the lowest.

Table 7 reports the predicted dollar price change and relative price change for the average house, both with and without zoning. An additional square meter of floor space increases the price by about \$500, about half of the 2005 rule of thumb that new construction costs \$100 per square foot. An additional full bathroom adds around 20% to the price of the average home, all other things equal, and an additional half bathroom adds about 12% to the price. The value benefit of having wood or oil heat is about \$7,000. The implied annual savings is then \$350 at a 5% discount rate and \$700 at 10%, amounts loosely consistent with local anecdotal evidence. Historic designation increases the price by almost \$40,000.

For neighbourhood effects, home prices increase by almost \$1,000 for one kilometre closer to Acadia university, and around \$1,500 for one kilometre closer to Main Street. While significant, these values are quite small. For a walking speed of four kilometres per hour, a 10% discount rate, and 200 walking trips per year, the imputed time cost is \$2 per hour. Wolfville residents either have a low opportunity cost of their time, or enjoy walking. A one decibel increase in peak sound level decreases the price of the average house by about \$2,700, a little under two percent of the price. This is in the range reported by other studies. In so far as quiet is a normal good, and the average income of Wolfville home purchasers is high, it seems reasonable that the price discount is in the upper range of values reported in other studies. Finally, the impact of zoning classification stands out particularly strong. Properties zoned R-1A allow one rental suite, R-2/4 allows up to four apartments in a house, R-8 allows up to eight apartments, and RCDD is a general development category, residential comprehensive development district. The difference between R-2/4 and R-1, more than $40,000, is greater than the price difference observed between the loudest and most quite parts of Wolfville, about 15%. In so far as zoning is segregating based on externalities, the segregation is capturing more than sound level effects.

TABLE 7 Dollar and Percentage Impact of a Unit Change in Selected Regressors

	Without Zoning		With Zoning	
Factor	$\Delta Price$	$\Delta\%$	$\Delta Price$	$\Delta\%$
AGE	−469.75	−0.4	−513.24	−0.3
FLOOR (m^2)	483.30	0.0	517.16	0.0
LOT (m^2)	15.92	0.0	17.39	0.0
Full Baths (FBATH)	26,630.37	20.7	29,095.79	19.0
Half Baths (HBATH)	15,854.17	12.3	17,321.94	11.3
Bedrooms (BEDS)	−1,510.87	−1.2	−1,650.74	−1.1
WELL	−21,840.91	−17.0	−4,539.19	−3.0
Heat: OIL	10,647.61	8.3	4,799.25	3.1
Heat: WOOD	11,868.06	9.2	2,881.71	1.9
Heat: OTHER	27,655.59	21.5	36,065.30	23.5
HISTORIC	39,808.61	31.0	38,579.43	25.1
to town CENTRE (km)	1.95	0.0	2.13	0.0
to ACADIA (km)	−895.50	−0.7	−978.40	−0.6
to MAIN Street (km)	−1,493.05	−1.2	−1,631.27	−1.1
PEAK (dB)	−2,618.05	−2.0	−2,860.43	−1.9
Zone: R-1A			−19,717.19	−12.9
Zone: R-2/4			−42,518.50	−27.7
Zone: R-8			−10,956.21	−7.1
Zone: RCDD			−41,411.97	−27.0

Note: The comparison house has the average values for ratio scale variables. It is supplied with town water, has electric heat, does not have a view, and was sold in the first quarter of 2000. For the regression with zoning, it was also a single family residential zoned home.

As pointed out by Pogodzinski and Sass (1991), the pricing function may differ by zoning. Regressions including interactions between zoning and other variables did add some explanatory power, but multicollinearity and/or small sample size preclude accurate parameter estimation. Further, since both the signs and magnitudes of the parameter estimates did not change substantially, results for the interaction terms are not reported. Several variables, such as type of ownership (freehold vs leasehold), style of house (semi-detached or detached), type of house (single family or condominium), etc. were also included in the initial models as dummy variables. None of the dummies generated significant coefficients, and all were dropped. To limit potentially confounding factors, only single family residential properties with freehold title were included.

Given that the sound level discount is not adequate to explain the zoning code pricing impact, this impact likely reflects other characteristics of the Wolfville housing market. As discussed above, one of these is the importance of student rental accommodation. This rental market has created a pattern of zoning which places a concentration of multiple unit housing in the neighborhood of the university campus. In so far as home buyers do not desire living with university students as neighbours (e.g. due to externality effects such as loud parties and fears about behaviours children may be exposed to), demand is likely lower for homes near the university which are zoned for multiple units. This fact may be compounded by renovation costs. Many multiple unit houses are larger single family homes which have been converted into suites. Anyone purchasing such a property for use as a family home would face significant renovation costs. These buyers would therefore not be willing to pay as high a price for many of the R-2/4 or R-8 zoned homes, as for an R-1 zoned home which requires little or no modification. The R-1A effect is somewhat surprising, as such a house is unlikely to require much modification. However, since the owner of a house can always rent it to a group of students, proximity to the university may be a key variable as well in determining the presence of rental housing related externalities.

A key question is whether zoning in Wolfville is welfare improving. Ohls et al (1974) describe two purposes for zoning restrictions. Externality zoning is land use restrictions to minimize the impact of externalities. Such zoning can be Pareto improving. Fiscal zoning restrictions manage property use to achieve a fiscal objective such as minimising tax rates. Courant (1976) uses a general equilibrium model of a metropolitan area, based on the work of Ohls et al (1974), to show that fiscal zoning can only increase property prices and thereby reduce consumer welfare. Whether or not zoning practices are welfare improving for Wolfville depends on the size of externalities associated with rental (principally student) housing and the cost of other methods of controlling those externalities. Other methods of controlling these externalities include noise and litter regulations and maintenance standards. Enforcement of tenant behavior is likely difficult with transitory tenants such as students, so that using such regulations is likely to increase landlord costs. To the extent that landlords have disproportionate political power – not unlikely in a community with such a high portion of renting residents – zoning regulations will be the preferred instrument.

The overall efficiency of zoning depends on how differential externalities affect the involved parties. In general, the argument is that owner-occupied properties are negatively affected by being adjacent to renter occupied properties. Renters, or their landlords, are less likely to maintain the rented property to the same standard as an owner-occupier would. This generates a negative externality to the owner-occupier neighbour. A question seldom discussed is whether the owner-occupier generates a positive externality for the renter. Two mechanisms may exist for such an effect. First, the renter may enjoy viewing the well maintained homes and yards of nearby owner-occupiers, as well as the extra security in the neighbourhood, among other things. Second, neighbouring owner-occupiers may demand a higher standard of their renter neighbors and/or their landlords than would be expected if the neighbour is another rental property. Student ghettos may exist not because of student preference, but because students have imperfect information about their rights as tenants, and insufficient resources to enforce those rights – be that time or money. Landlords may prefer having student ghettos, as it reduces those maintenance costs related to neighborhood externalities. If these positive externalities exist, then the efficient zoning pattern may involve extensive mixing of zoning across areas, rather than having uniform zoning classifications for large areas. Assessing the willingness to pay among students for reduced neighborhood externalities is an area for further work. While students may be income constrained in this regards, relating commuting time to housing characteristics may enable such relationships to be established.

With respect to the possible twinning of Highway 101, this study suggests that peak sound events, such as passing tractor-trailer units, are reflected in property prices. If twinning increases traffic speed, then peak sound levels will also increase. If 300 homes, about one quarter of the homes in Wolfville, experience an average peak sound level increase of one decibel, the total damage cost is about $810,000. This amount needs to be compared to the cost of measures to reduce noise pollution associated with the highway expansion.

Conclusion

Overall, many of the factors affecting property values in Wolfville, Nova Scotia, are the same as those found elsewhere. In particular, property values are increasing in the area of the house, the area of the lot, and the number of bathrooms. Of the two externalities measured – sound levels and the presence of a view, only peak sound level was found to be significant. At the average house price, a one decibel increase in peak sound levels reduces the house price by just under two percent. Two interesting results stand out. First, the impact house age has on price is not that large, and reaches the maximum discount at about eighty years. Further, there is a positive premium attached to historic properties. Purchasers in Wolfville appear willing to pay a premium for older homes. Second, there is a strong negative effect of zoning designations that allow rental accommodation. Since Wolfville is a university town, this is likely due to a 'student ghetto' effect.

Whether land use segragation is welfare improving is a question that this research again raises. Further research should seek to measure the welfare impacts on student tenants and other renters, to assess willingness to pay for different forms of housing, and quality of life impacts of living in a student ghetto. Repeating this research in other small university towns, such as Sackville, New Brunswick and Antigonish, Nova Scotia, would confirm the current results and to the extent that land use patterns offer different mixes of student and non-student housing, could indicate welfare improving arrangements. A regression of student rental rates against property and neighbourhood characteristics could capture the willingness of students to pay for a better maintained neighbourhood. A contingent valuation or similar survey could also measure the willingness to pay by student tenants for better maintained housing.

Several policy interventions could reduce the size of the rental housing externality. Stricter rental property maintenance standards and enforcement of those standards could be implemented. However, these would be opposed by landlords. Changing zoning regulations to mix rental properties with owner occupied properties could similarly enforce stricter maintenance of rental properties. However, such a change would likely be opposed by landlords, owners who live in their homes, and student tenants who may face longer commutes. A simpler policy may be to better inform student tenants of their rights, and provide them with an advocate at city hall to pursue complaints about poor maintenance. Such an office may be a more cost effective way to reduce the 'ghetto' aspect of neighbourhoods dominated by student housing, while not actually implementing any new regulations, and thereby reduce the opposition from landlords.

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