An Examination of Vertical Equity Over Two Reassessment

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Abstract

This article examines vertical equity in the assessment of single-family homes over two assessment cycles in Bellingham, Washington. The two assessment periods, which are four years apart, followed two differing property appreciation periods. The 1992 reassessment followed an explosion in home values, while the 1996 reassessment came after more moderate price appreciation. The assessed value/market value ratio is the basic tool of this study with actual sales prices assumed to be market value. Utilizing a database of 721 home sales from January, 1990 to December, 1992, this study's empirical analysis suggests regressive vertical inequity in 1992. This situation appears to have changed in 1996. Results from a second database consisting of 835 home sales from January, 1994 through December, 1996, suggest a substantial reduction in vertical inequity. Overall, it appears that the County Assessor's office addressed the previous problem with positive results for the average property taxpayer of Whatcom County.

Introduction

The processes by which taxes are levied on real property have been an ongoing cause of controversy in many states. This article examines the valuation of homes for property tax purposes by a county assessor's office in Washington over successive assessment cycles. This study is unique in that it is the first to examine the impact of the reassessment process on the vertical equity of property tax assessments.

Vertical equity is the concept that all properties are evenly assessed according to their fair market value. For example, the assessed value of a $400,000 home should be four times that of a $100,000 home if assessments fairly reflect incremental value. The assessed value/market value ratio (AV/MV) is commonly used in studies of vertical equity. Vertical equity exists if all properties on a tax roll have similar AV/MV ratios. Vertical inequity occurs when AV/MV ratios are not uniform across property value categories. Regressive vertical inequity is the

result of higher AV/MV ratios for lower valued homes and suggests that expensive homes are underassessed. Progressive vertical inequity is evident if relatively expensive homes have higher AV/MV ratios than relatively inexpensive homes.

Benson and Schwartz (1997) studied 1992 property tax assessments and found evidence suggesting regressive vertical inequity. Higher valued homes were assessed at lower AV/MV ratios than lower value homes in that assessment cycle. This study is a successor to that one in that it examines vertical equity in the same real estate market following the 1996 reassessment. Evidence presented suggests that the degree of vertical inequity was substantially reduced in the later assessment cycle.

Vertical equity is mandated by state law or constitution in most states. In Washington, for example, state law requires that county assessors must assess all properties for property tax purposes at 100% of market value. Verification of vertical equity is often the function of a state agency designated to assure compliance by county assessors. A thorough explanation of Washington and Bellingham property tax policies is in Benson and Schwartz (1997).

The residential property market in Bellingham, Washington had significant price appreciation from 1988 to 1994 with the typical single-family home climbing in value from approximately $70,000 to over $140,000. Assessed values rose as well, as the county assessor increased values to comply with state law. The assessor follows a four-year reassessment cycle, that is, assessed values are adjusted every four years (one-quarter of the county is reassessed annually). As expected, there have been sizeable increases in assessed values following the large increases in market prices.

This study examines vertical equity in Bellingham (by comparing assessed values and market sales prices) over two successive reassessment cycles. In particular, it examines the vertical equity in property assessments based on the 1996 assessments of South Bellingham properties compared to the vertical equity based on the 1992 assessments. The statistical methodologies used in Benson and Schwartz (1997), where they found some degree of vertical inequity in the 1992 assessments, are used here for the 1996 assessments. The next section includes a brief literature review and a discussion of the Bellingham market and the reassessment process. A discussion of the data and the empirical analysis follow.

Literature Review

Previous research is not uniform in its findings regarding the existence of vertical equity. Many studies focus on methodological issues of measurement. An overview of the research and various methodologies is contained in Sirmans, Diskin and Friday (1995). That article not only is a thorough review of the vertical equity literature but also contains extensive analysis that utilizes many of the conflicting methodologies. Utilizing a database of 1,508 owner-occupied home sales in Dade County (Miami), Florida, in 1991, the authors draw no firm

conclusions regarding vertical inequity. An examination of the data scatter diagrams and of the empirical results indicates that evidence of vertical inequity is a function of which methodology is employed in the analysis. There does not appear to be glaring evidence of vertical inequity although several regression results are statistically significant.

Benson and Schwartz (1997) have a review of the vertical equity literature that preceded Sirmans, Diskin and Friday (1995). Additionally, they examine vertical equity in Bellingham, Washington, using several of the models suggested by earlier studies. They use the 1992 assessed value and the assessed value/sales price ratio as the dependent variable and sales price as the explanatory variable, and they employ the spline regression technique. Their results suggest evidence of regressive vertical inequity, as shown by relatively low assessed value to sales price ratios for homes selling for $400,000 and above. This article extends that work by comparing assessed values and sales prices for the 1990–1992 period with a more recent period, 1994–1996, to examine vertical equity over two reassessment cycles.

The Bellingham Market and the Reassessment Process

The Bellingham residential property market has been discussed in detail by Benson and Schwartz (1997) and in Benson, Hansen, Schwartz and Smersh (1998, 1999), (BHSS). Following a period of significant price increases in the late 1980's and early 1990s, housing prices rose at a much slower pace between 1993 and 1996, as seen in Exhibit 1. The recent diminution in home price increases can be attributed to increased production of new homes, to a reduced level of in-migration from outside the area and to affordability. In the early 1990s, Bellingham home prices reached levels that were less affordable for many potential homebuyers. Local incomes did not rise as fast as home prices in the 1988 to 1994 period, and the recent tempering of home price increases may reflect a ''catch-up'' phase in the marketplace

Valuing property for tax purposes is the responsibility of the Whatcom County Assessor, a non-partisan elected position, with a term of office of four years. Washington state law requires that property be periodically reassessed to reflect the legal requirement that assessed values equal 100% of market value.[1] In practice, most properties, when they are reassessed, appear to have an assessed value to selling price ratio of about 85% to 90%. This ratio of assessed value to actual selling price may be influenced by such factors as the costs of sale, the type of financing used and personal property included in the sale. In addition, the assessor probably seeks to avoid large numbers of appeals after a reassessment by pursuing a goal of slight underassessment. The assessor reassesses one-quarter of the county each year. This is accomplished by splitting the city of Bellingham in half and the balance of Whatcom County in half, with each of those quarters being reassessed every four years.

Exhibit 1 | Whatcom County Single Family Home Sales, 1983–1996

Year	Number of Sales	Average Sales Price ($)	Annual % Change in *SP*	Four-Year % Change in *SP*	Total Transaction Volume (millions)	Price Per Square Foot
1983	1,607	62,079			100	49
1984	1,264	63,068	1.59		80	49
1985	1,769	59,940	−4.96		106	46
1986	1,833	62,183	3.74		114	46
1987	1,954	65,081	4.66	5	127	49
1988	2,663	70,201	7.87	11	187	51
1989	3,173	82,347	17.30	37	261	60
1990	2,683	109,351	32.79	75	293	85
1991	2,431	116,353	6.40	79	283	86
1992	2,733	124,788	7.25	78	341	91
1993	2,623	132,104	5.86	60	347	95
1994	2,455	140,008	5.98	28	344	93
1995	2,154	140,692	0.49	21	303	96
1996	2,288	143,715	2.15	15	329	99

Source: Whatcom County Real Estate Research Reports, 1984–1997.

Given the high rates of home price appreciation in 1987–1992, many Bellingham homeowners had large increases in assessments in 1992. This resulted in large property tax increases as local taxing authorities did not lower tax rates to reflect the higher values on the tax rolls. Referring again to Exhibit 1, the rate of price appreciation of single-family homes from 1992–1995 substantially diminished from the torrid pace of the previous four years. Between 1992 and 1995, the average home price rose 21% as compared to a 79% increase in the previous four years. The reassessment in 1996 resulted in much smaller increases in assessed value than occurred in 1992.

Washington law requires that all home sales be reported to the county authorities at the actual transaction. In contrast to states such as Wyoming, the property transfer process in Washington is totally transparent—that is, all terms and the full sales price of all transactions are supposed to be fully disclosed. The County Assessor has full access to the sales data and these are the basic database of this study. The assessor collects data that include many hedonic characteristics of each home such as number of bedrooms and of baths, square footage, type of heating, garage size or lack thereof, and many other items. The Assessor's database does

not include the view of the home, a characteristic that BHSS (1998) found to be a very important value determinant for many homes in Bellingham.

Despite a booming property market and a significant increase in the number of parcels to assess, the Whatcom County Assessor's Office was severely constrained in the 1991 to 1996 period, in that only two additional appraisers were added. This limitation on resources did not prevent the assessor from correcting the regressive vertical inequity that occurred from the 1992 reassessment. The lessening of vertical inequity in the 1996 reassessment is apparent from the analysis that follows.

Data

Two separate databases are utilized for this study. The first database is comprised of 721 home sales in the southern half of Bellingham from January, 1990 through December, 1992. Data were supplied by the Whatcom County Assessor and include the reported sales price, sales date and the 1992 assessed value. This database is described further in Benson and Schwartz (1997) and in BHSS (1998, 1999). The database includes only those sales that appear to be arm's-length transactions (sales not meeting that criteria, for example, sales between family members, estate sales and foreclosures, were not included).

Unique to this article, a second database was assembled that includes 835 home sales in the southern half of Bellingham from January, 1994 through December, 1996. These data were also supplied by the Whatcom County Assessor and include the reported sales price, sales date and the 1996 assessed value. This second database matches the one described in the previous paragraph in that both include home sales in the two years previous to the assessment year and home sales in the assessment year.

This second database began with 4,325 real estate transactions in all of Bellingham from January, 1994 through March, 1997. After sales of condominiums, raw land and non-warranty deed sales were removed, the database included 3,046 transactions. Next, transactions were removed from the database that were given a ''rejection code'' by the Whatcom County Assessor's Office because the sale did not appear to be a market (or arm's length) transaction. After a few additional transactions were removed because of missing data, the database contained 2,597 home sales. Of these, only 835 were home sales in the southern half of Bellingham during the January, 1994 to December, 1996, period.

The southern half of Bellingham includes the substantial majority of upper-end homes and previous research suggests that vertical inequity was present in that price category. As stated earlier, homes in Bellingham are assessed every four years, and the homes in the southern half of the city were assessed in 1992 and 1996. The data for this study are from the southern half of the city of Bellingham. This assures that the assessment data comes from a data set where all the homes were assessed on the same assessment cycle and at the same time.

Empirical Analysis

Testing Vertical Equity by Examining Assessment Ratios

Vertical equity in assessments over time may be examined by looking at the assessed value to sales price (AV/SP) ratios for different value categories of home sales. The AV/SP ratios for Bellingham for the two sets of three-year periods, 1990–92 and 1994–96, are shown in Panel A of Exhibit 2 for six different value categories. As discussed, vertical equity would be suggested by the data if each home value category has a similar AV/SP ratio in a given year. One would expect to see the ratio decreasing if regressive vertical inequity exists (or increasing, showing progressive inequity), as the sales price rises. For the 1990–92 data, the assessments were made in the Spring of 1992, and for the 1994–96 data, the assessments were made in the Spring of 1996. The sales prices are the actual reported sales prices in each of the given years. Thus, for the first three-year period, only the 1990 and 1991 sales prices were known at the time of the assessment, plus some knowledge of the early 1992 sales prices. For the second three-year period, only the 1994 and 1995 sales prices were known with some knowledge of the early 1996 sales.

The 1990 to 1992 data in Exhibit 2 suggest that some rather significant regressive inequity existed at that time as shown by the AV/SP ratios in Panel A that decline fairly steadily as the sales price rises. The homes that sold for more than $400,000 had the lowest ratios by a significant margin in all three years, and the lowest sales price category had the highest ratios in all three years.

The evidence from the 1994–96 data suggests that the degree of vertical inequity was significantly reduced, once the 1996 assessments were made. For 1994 and 1995 sales, the AV/SP ratios for the homes that sold for more than $400,000 are still below average, but not nearly as far below the average as in the earlier period. For 1996, the AV/SP ratio for the $400,000+ category is actually above the average for all categories of homes sold that year.

Another way to examine vertical equity is to examine the percentage of homes in each category that were assessed at 80% or more of the sales price in a given year. Panel B of Exhibit 2 shows that 50% (two of the four) of the $400,000+ homes that sold in 1990 and 1991 were assessed in 1992 at 80% or more of the selling price. This percentage, however, increases to 83% (ten of twelve) of the $400,000+ homes that sold in 1994 and 1995 and were assessed in 1996. In the second time period, only the 1994 sales data suggest some significant underassessment of high-value homes.

Thus, the evidence from Exhibit 2 suggests that the regressive vertical inequity, present in the 1990–92 data, was much less severe when looking at the 1994–96 data. The later period utilizes the 1996 assessments, and it appears that AV/SP ratios for the $400,000 and above sales price category are much closer to the

Exhibit 2 | Assessed Value / Sales Price Ratios by Year of Sale and Sales Price Category
(Assessed Values are for 1992 and 1996)

	Year of Sale											
	1990		1991		1992		1994		1995		1996	
Sales Price	*N*	*AV/SP*	*N*	*AV/SP*	*N*	*AV/SP*	*N*	*AV/SP*	*N*	*AV/SP*	*N*	*AV/SP*
Panel A: Number of Observations and Mean AV/SP by Year												
$400,000 and higher	1	.61	3	.78	3	.67	8	.83	4	.84	11	.89
$250,000 to $399,999	14	.86	18	.86	28	.79	39	.89	31	.88	29	.86
$150,000 to $249,999	47	.86	72	.86	75	.80	104	.88	82	.89	93	.88
$125,000 to $149,999	35	.94	31	.87	42	.81	57	.88	52	.88	75	.88
$100,000 to $124,999	34	.93	28	.87	36	.79	50	.86	51	.88	50	.88
Less than $100,000	108	.98	80	.89	66	.85	34	.91	36	.93	29	.93
Totals / Averages	239	.93	232	.87	250	.81	292	.88	256	.89	287	.88
Panel B: Percentage of Prperties Sold with an AV/SP Ratio of 0.80 or Higher												
$400,000 and higher	0		67		0		75		100		82	
$250,000 to $399,999	71		72		46		92		84		76	
$150,000 to $249,999	77		76		49		89		95		82	
$125,000 to $149,999	89		77		57		88		92		85	
$100,000 to $124,999	85		79		53		86		92		76	
Less than $100,000	86		79		67		88		83		97	
Average Percentage	84		77		55		88		91		83	

AV/SP ratio for the overall sample in contrast to the results based on 1992 assessments. However, even for the later period, there still seems to be some tendency for high-value homes to have slightly lower AV/SP ratios and for low value homes to have slightly higher ratios, relative to the average of all homes.

Testing Vertical Equity Using Quantitative Models

This study now turns to the use of quantitative models that have been developed in the literature to test for the presence of vertical equity, as used in Benson and Schwartz (1997). The models used in this study assume that the sales price (*SP*) of a home is the best estimate of the true value (or market value) of a home, that is, the assessed value (*AV*) or the assessment ratio (*AV*/*SP*) is used as the dependent variable and the sales price as the independent (or explanatory) variable. In an environment of rational valuation, the assessed value should be a function of (or be determined by) sales price.

The models used in this study include those of the following three forms:

1. $AV = a_0 + a_1SP$;
2. $AV/SP = a_0 + a_1SP$; or
3. $AV = a_0 + a_1SP + a_2LOW + a_3HIGH + a_4LOW^* SP + a_5HIGH^* SP$.

Where, *LOW* and *HIGH* are equal to 1 if home price levels are below or above that level which one may expect to find some degree of vertical inequity compared to the mid-range of home prices. The models are estimated for each separate year of the each three-year period and for each period as a whole. For 1990–92, when the models are estimated using data from all three years, the sales prices are inflated or deflated to the second quarter of 1992. The housing price index series used for this was developed in BHSS (1999).[2] For 1994–96, the sales values were not adjusted when the models are estimated using data from all three years, because sales prices did not change significantly over the period.

The $AV = a_0 + a_1SP$ *Model*. This model may be specified in either linear or nonlinear form. Paglin and Fogarty (1972) specify the variables in linear form. Using the linear form, the estimates of a_0 and a_1 are shown in Panel A of Exhibit 3 for 1990–92. If vertical equity exists in the assessment process, each regression line would originate from the origin and would have a slope coefficient approximately equal to the *AV*/*SP* ratio shown in Panel A of Exhibit 2. The positive (and significant) intercept terms, a_0, in Panel A of Exhibit 3 suggest the presence of regressive vertical tax inequity. The slope coefficients, a_1, show that assessed value goes up by about seventy-eight cents for each dollar increase in sales price for the 1990 and 1991 home sales.

For 1994–96, the estimates of a_0 and a_1 are shown in Panel A of Exhibit 4. The positive intercept terms, a_0, are significant only for 1994 and 1995 and suggest some mildly regressive vertical tax inequity. The slope coefficients, a_1, show that

Exhibit 3 | 1990–1992 Regression Estimates for the $AV = a_0 + a_1 SP$ Models

Year of Sale	a_0	*t*-Stat.	a_1	*t*-Stat.	a_2	*t*-Stat.	R^2	*N*
Panel A: $AV = a_0 + a_1 SP$								
1990	14,992	6.00	0.785	44.98			.8952	239
1991	11,473	4.55	0.785	52.85			.9239	232
1992	10,765	3.74	0.731	45.34			.8923	250
1990–1992	12,446	8.19	0.727	82.60			.9047	721
Panel B: $AV = a_0 + a_1 SP + a_2 SP^2$								
1990	1,782	0.40	0.971	17.61	-5.00×10^{-7}	−3.56	.9005	
1991	−11,273	−3.14	1.039	30.45	-5.23×10^{-7}	−8.08	.9408	
1992	−1,975	−0.43	0.871	20.25	-2.94×10^{-7}	−3.50	.8974	
1990–1992	−2,194	−0.92	0.894	38.66	-3.53×10^{-7}	−7.73	.9120	
Panel C: $AV = a_0 + a_1(\ln SP)$								
1990	−1,121,831	−29.79	106,324	32.84			.8198	
1991	−1,420,020	−35.44	131,311	38.67			.8667	
1992	−1,280,244	−29.54	118,694	32.48			.8097	
1990–1992	−1,274,107	−53.85	118,313	59.09			.8292	
Panel D: $\ln AV = a_0 + a_1(\ln SP)$								
1990	1.549	6.33	0.860	40.82			.8755	
1991	0.361	1.65	0.957	51.79			.9210	
1992	0.601	2.34	0.931	42.99			.8817	
1990–1992	0.820	5.88	0.913	77.31			.8926	

Exhibit 4 | 1994–1996 Regression Estimates for the $AV = a_0 + a_1 SP$ Models

Year of Sale	a_0	*t*-Stat.	a_1	*t*-Stat.	a_2	*t*-Stat.	R^2	N
Panel A: $AV = a_0 + a_1 SP$								
1990	6,245	3.13	0.844	83.73			.9603	292
1991	4,252	2.18	0.855	79.76			.9616	256
1992	3,302	1.27	0.859	63.96			.9349	287
1990–1992	4,673	3.65	0.852	127.75			.9514	835
Panel B: $AV = a_0 + a_1 SP + a_2 SP^2$								
1990	−10,741	−3.27	1.007	36.63	-3.01×10^{-7}	−6.29	.9651	
1991	−984	−0.25	0.912	23.69	-1.27×10^{-7}	−1.54	.9620	
1992	−4,532	−0.81	0.938	18.28	-1.58×10^{-7}	−1.59	.9354	
1990–1992	−6,909	−2.95	0.969	46.22	-2.32×10^{-7}	−5.85	.9534	
Panel C: $AV = a_0 + a_1(\ln SP)$								
1990	−1,866,979	−46.82	168,739	50.76			.8988	
1991	−1,619,671	−40.06	148,033	43.69			.8826	
1992	−1,838,164	−38.85	166,293	42.11			.8615	
1990–1992	−1,781,523	−71.54	161,592	77.69			.8787	
Panel D: $\ln AV = a_0 + a_1(\ln SP)$								
1990	0.020	0.13	0.988	76.70			.9530	
1991	0.315	1.75	0.963	63.80			.9413	
1992	0.219	1.08	0.971	57.23			.9199	
1990–1992	0.179	1.73	0.974	112.53			.9383	

assessed value goes up by about eighty-five cents for each dollar increase in sales price for the 1994 and 1995 home sales. The 1996 home sales data do not reflect any vertical inequity. Comparing Panel A of Exhibits 3 and 4, the intercept terms are smaller and less significant for the 1994–96 data and the slope coefficients are larger, suggesting that degree of vertical inequity has been significantly reduced in the latest assessment period.

A quadratic specification, $AV = a_0 + a_1SP + a_2SP^2$, implies that the relationship between *SP* and *AV* is not linear. Using this specification, suggested by Bell (1984), provides the estimates shown in Panel B of Exhibits 3 and 4. The R^2 value for each of these annual regressions is higher than for the linear model, suggesting that the relationship between *AV* and *SP* is not linear. In Exhibit 3, the a_2 coefficient is significantly negative in each case, confirming the nonlinearity of the model and indicating that the rise in *AV* slows down relative to the rise in *SP*, as higher value homes are considered. In Exhibit 4, however, only the a_2 coefficient for 1994 is significantly negative when looking at the individual year data, suggesting little or no vertical inequity in the 1995 and 1996 data.

An alternative nonlinear specification to that of the quadratic specification is a log specification of the explanatory variable, $AV = a_0 + a_1(\ln SP)$. Using this model provides the estimates provided in Panel C of Exhibits 3 and 4. An examination of the R^2 terms suggests that the previous quadratic model is superior to this log specification.

A log-linear specification, $\ln AV = a_0 + a_1(\ln SP)$, is suggested by Cheng (1974). This model provides the estimates shown in Panel D of Exhibits 3 and 4. Regressive tax inequity is suggested if the coefficient, a_1, is less than one and is statistically inequivalent to one. The coefficient, a_1, is an elasticity coefficient, that estimates the percentage change in *AV* for a given percentage change in *SP*. *t*-tests (not shown here) of the difference between a_1 and one indicate that all of the a_1 coefficients in Exhibit 3 are significantly lower than one; and in Exhibit 4 only the a_1 coefficient for 1995 is significantly different from one, for the annual regressions, as well as the coefficient for the 1994–96 period regression.

The $AV/SP = a_0 + a_1SP$ Model. The model that uses *AV*/*SP* as the dependent variable may, also, be specified in either linear or nonlinear form. In linear form, the model is referred to as the IAAO (1978) model. When the variables are specified in linear form, the estimates of a_0 and a_1 are as shown in Panel A of Exhibits 5 and 6 for each year used in this study. In Exhibit 5, the significant negative coefficients for a_1 for each year and for the entire period, 1990 through 1992, indicate the presence of regressive tax inequity. In Exhibit 6, the a_1 coefficient is negative and significant for 1995 only, as well as for the 1994–96 estimate. The R^2 for each regression is low because the sales price alone does not provide a good explanation of why *AV*/*SP* varies from one property to another. Sirmans, Diskin and Friday (1995) also had a very low R^2 using this model to analyze their Miami, Florida data.

Exhibit 5 | 1990–1992 Regression Estimates for the $AV/SP = a_0 + a_1 SP$ models and the Piecewise Spline Model

Year of Sale	a_0	a_1	a_2	a_3	a_4	a_5	R^2
Panel A: $AV/SP = a_0 + a_1 SP$							
1990	1.036	-8.10×10^{-7}					.1063
	47.44	−5.31					
1991	0.907	-2.34×10^{-7}					.0281
	58.97	−2.58					
1992	0.861	-3.06×10^{-7}					.0328
	45.76	−2.90					
1990–1992	0.936	-4.22×10^{-7}					.0526
	81.21	−6.32					
Panel B: $AV/SP = a_0 + a_1(\ln SP)$							
1990	2.597	−0.143					.1657
	10.70	−6.86					
1991	1.365	−0.042					.0301
	7.40	−2.67					
1992	1.634	−0.069					.0580
	7.77	−3.91					
1990–1992	1.925	−0.089					.0814
	14.58	−7.98					

Exhibit 5 | (continued)

1990–1992 Regression Estimates for the $AV/SP = a_0 + a_1 SP$ models and the Piecewise Spline Model

Year of Sale	a_0	a_1	a_2	a_3	a_4	a_5	R^2
Panel C: $AV = a_0 + a_1 SP + a_2 LOW + a_3 HIGH + a_4 LOWSP + a_5 HIGHSP$							
1990	15,499	0.793	10,403	97,396	−0.182	−0.314	.9038
	2.22	17.39	0.95	3.79	−1.51	−3.51	
1991	4,056	0.838	11,347	100,506	−0.146	−0.309	.9398
	0.64	21.64	0.82	7.05	−0.94	−5.85	
1992	−4,197	0.830	11,473	62,449	−0.081	−0.248	.9006
	−0.64	20.65	0.78	4.18	−0.48	−4.33	
1990–1992	5,642	0.775	14,963	69,421	−0.179	−0.226	.9132
	1.48	33.16	1.88	7.75	−2.01	−6.80	

Note: t-Stats appear on the second line.

Exhibit 6 | 1994–1996 Regression Estimates for the $AV/SP = a_0 + a_1 SP$ Models and the Piecewise Spline Model

Year of Sale	a_0	a_1	a_2	a_3	a_4	a_5	R^2
Panel A: $AV/SP = a_0 + a_1 SP$							
1990	0.894	-6.80×10^{-8}					.0056
	84.86	−1.28					
1991	0.913	-1.61×10^{-7}					.0165
	64.04	−2.06					
1992	0.899	-9.67×10^{-8}					.0061
	63.47	−1.32					
1990–1992	0.901	-1.03×10^{-7}					.0084
	121.08	−2.65					
Panel B: $AV/SP = a_0 + a_1(\ln SP)$							
1990	1.026	−0.012					.0041
	7.77	−1.09					
1991	1.384	−0.042					.0338
	8.27	−2.98					
1992	1.239	−0.030					.0142
	7.03	−2.02					
1990–1992	1.209	−0.027					.0150
	13.23	−3.57					

Exhibit 6 | (continued)

1994–1996 Regression Estimates for the $AV/SP = a_0 + a_1 SP$ Models and the Piecewise Spline Model

Year of Sale	a_0	a_1	a_2	a_3	a_4	a_5	R^2
Panel C: $AV = a_0 + a_1 SP + a_2 LOW + a_3 HIGH + a_4 LOWSP + a_5 HIGHSP$							
1990	−1,108	0.885	2,700	59,408	0.008	−0.182	.9657
	−0.27	34.89	0.13	6.56	0.03	−5.29	
1991	2,678	0.898	33,345	28,134	−0.356	−0.110	.9635
	0.71	38.00	2.62	2.65	−2.42	−2.82	
1992	−2,548	0.896	34,363	16,964	−0.355	−0.069	.9357
	−0.49	27.71	1.49	1.24	−1.35	−1.42	
1990–1992	−2,112	0.893	26,410	37,155	−0.267	−0.127	.9535
	−0.82	55.53	2.51	5.82	−2.22	−5.40	

Note: t-Stats appear on the second line.

A log specification of the explanatory variable, $AV/SP = a_0 + a_1(\ln SP)$, provides the estimates shown in Panel B of Exhibits 5 and 6. Looking at the R^2 values, these results are somewhat better than the linear model. In Exhibit 5, the significant negative coefficients for a_1 again indicate the presence of regressive tax inequity. In Exhibit 6, the a_1 coefficient is negative and significant for both the 1995 and 1996 sales data.

The Piecewise Spline Model. The piecewise spline model, proposed by Sunderman, Birch, Cannaday and Hamilton (1990) is of the form, $AV = a_0 + a_1SP + a_2LOW + a_3HIGH + a_4LOWSP + a_5HIGHSP$, where: *LOW* is equal to one if the home's sale price is less than the first knot, otherwise zero; *HIGH* is equal to one if the home's sale price is above the second knot, otherwise zero; *LOWSP* is the home's sale price if it is less than the first knot, otherwise zero; and *HIGHSP* is the home's sale price if it is greater than the second knot, otherwise zero.

The estimated *LOW* and *HIGH* "knots" that separate the low and high price ranges from the middle price range are \$100,000 and \$249,999.[3] The model estimates are given in Panel C of Exhibits 5 and 6. Vertical equity is measured with coefficients a_0, a_2 and a_3. The analysis will focus on the 1990–1992 estimates and the 1994–1996 estimates shown in the last row of Exhibits 5 and 6, respectively.

In Panel C of Exhibit 5, the intercept term, a_0 (or \$5,642), indicates that there is no tax inequity in the middle segment, since the term is insignificantly different from zero. The intercept for the lower segment is \$20,605, $a_0 + a_2$, (or \$5,642 + \$14,963). This term is significantly different from zero, suggesting some regressive inequity in the lower segment. The intercept for the upper segment is \$75,063, $a_0 + a_3$ (or \$5,642 + \$69,421). This intercept is highly significant, indicating the presence of regressive inequity in the upper segment.

The slope of the middle segment is a_1, the coefficient for *SP*. For the 1990–1992 estimates, this value is 0.77. The slope of the lower segment is 0.59, $a_1 + a_4$ (or $0.77 - 0.18$). The slope of the upper segment is 0.54, $a_1 + a_5$ (or $0.77 - 0.23$). The slope of both the lower and upper segments is significantly less than is the slope of the middle segment, suggesting that the relationship between assessed value and sales price is quite different for these segments than it is for the middle segment that shows no vertical inequity.

An examination of the annual regressions for the piecewise spline model in Exhibit 5 indicates that the intercept and slope coefficients for the lower segment, a_2 and a_4, are not significant. However, the coefficients for the upper segment, a_3 and a_5, are highly significant for all years. The intercept for the upper segment is higher than that for the middle segment in all years, and the slope of the line is less. Thus, regressive inequity seems to be present in the range of homes that have sold for \$250,000 and up for the 1990–92 period.

In Panel C of Exhibit 6, the intercept term, a_0 (or −\$2,112), indicates that there is no tax inequity in the middle segment, since the term is insignificantly different

from zero. The intercept for the lower segment is \$24,298, $a_0 + a_2$, (or −\$2,112 + \$26,410). This term is significantly different from zero, suggesting some regressive inequity in the lower segment. The intercept for the upper segment is \$35,043, $a_0 + a_3$ (or −\$2,112 + \$37,155). This intercept is highly significant, indicating the presence of regressive inequity in the upper segment.

The slope of the middle segment is a_1, the coefficient for *SP*. For the 1994–1996 estimates, this value is 0.89. The slope of the lower segment is 0.62, $a_1 + a_4$ (or 0.89 − 0.27). The slope of the lower segment is significantly less than the slope of the middle segment. The slope of the upper segment is 0.76, $a_1 + a_5$ (or 0.89 − 0.13), and this slope is significantly less than is the slope of the middle segment. These results suggest that the relationship between assessed value and sales price is less strong in the lower and upper segments than it is for the middle segment that shows no vertical inequity.

An examination of the annual regressions for the piecewise spline model in Exhibit 6 indicates that the intercept and slope coefficients for the lower segment, a_2 and a_4, are significant only for the 1995 sales data. The coefficients for the upper segment, a_3 and a_5, are significant using both 1994 and 1995 home sales. Thus, regressive inequity seems to be present to some extent when looking at the 1994–96 sales data in comparison to 1996 assessments, but to a much lesser degree than is true for the 1990–92 data (using 1992 assessments).

Conclusion

This study is the first to examine single family home value reassessments for property taxes over two consecutive reassessment cycles. In Bellingham, Washington, vertical equity is measured for the 1992 and the 1996 reassessment cycles. Regressive vertical inequity, a lower relative assessment of expensive homes, is apparent for the 1992 assessment cycle. The incidence of regressive vertical inequity diminishes substantially following the 1996 reassessment. Fewer expensive homes have relatively low AV/MV ratios in 1996 than in 1992, and the average AV/MV ratio for the high end rose in 1996. While there are some expensive homes with below average AV/MV ratios, the degree of regressive vertical inequity has substantially lessened. The results of this study suggest that the overworked, understaffed County Assessor's office did a creditable job in correcting the regressive vertical inequity problem of the 1992 reassessment. The more stable Bellingham real estate market was probably a contributing factor in the improved reassessment process, as the four-year price increase was just over 20% for the average home in the 1992–1995 period, compared to nearly 80% in the 1988–1991 period. Further ''fine tuning'' could possibly eliminate any remaining vestiges of regressive vertical inequity in Bellingham, assuring a fairer, less regressive overall tax regime.

Endnotes

[1] Washington state law requires that county assessors value all properties for property tax purposes at 100% of market value. Additionally, it is illegal to have any properties assessed at over 100%. The assessor tries to value properties at the highest possible level of uniformity that is just below 100%, without having any single property exceeding 100% of market value. This may explain why the average assessment may approximate 90% of actual sales price.

[2] The housing price index series developed in BHSS (1999) is:

Quarter	Price Index (1984:1 = 100)	Price Index (1992:2 = 100)	Quarter	Price Index (1984:1 = 100)	Price Index (1992:2 = 100)
1984:1	1.000				
1990:1	1.562	0.809	1991:3	1.872	0.970
1990:2	1.745	0.905	1991:4	1.865	0.967
1990:3	1.785	0.925	1992:1	1.915	0.992
1990:4	1.790	0.928	1992:2	1.929	1.000
1991:1	1.791	0.928	1992:3	2.029	1.052
1991:2	1.831	0.949	1992:4	2.015	1.044

[3] The knots were determined through observation of the data and by empirical analysis. Many other values were tried but provided an inferior fit for the model. Changes in these values by 5% – 10% have only an insignificant impact on the model estimates. The knot values are unique to Bellingham home sales for the period under observation.

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