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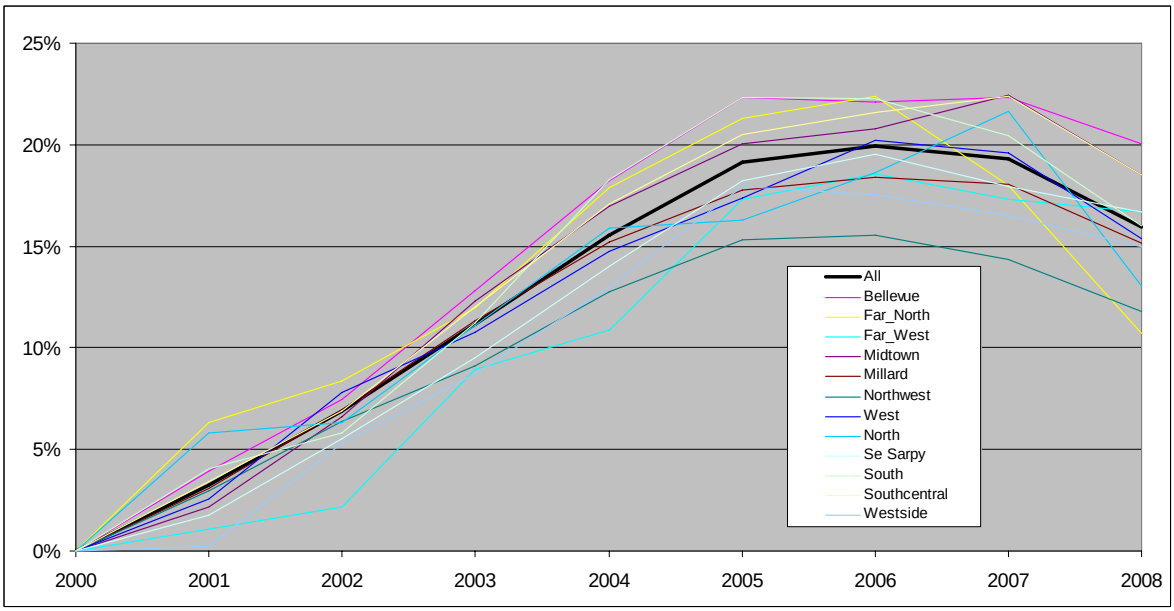
Single Family Housing Price Appreciation in Omaha (2000-2008)



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EXECUTIVE SUMMARY

This report summarizes the use of hedonic regression modeling to quantify annual changes in the appreciation of single-family housing prices in the Omaha metropolitan area. Such estimates take into account the varying structural characteristics and locations of sold homes and only statistically significant estimates are reported.

Between 2000 and 2008 across the metro area (excluding Council Bluffs and excluding condominium and townhome sales, and homes sold for less than $30,000 or more than $525,000), housing prices appreciated by 15.9% (or on average around 2% per year). Over the 2006 to 2008 period, prices declined by 4% (0.7% in 2007 and 3.3% in 2008).

However, price appreciation across different neighborhoods (market segments) varies by much larger amounts. Across 12 markets defined by school districts, city and county boundaries and areas of homogenous housing stock, price appreciation from 2000 to 2008 ranged from 13.1% to 20%, and from -1.9% to -11.7% over the 2006 to 2008 period. Alternatively, across 37 even more detailed neighborhoods/market segments, price appreciation ranged from 8% to 34% over the 2000 to 2008 period and from -12% to 3% over the 2006 to 2008 period.

In addition to strong geographic (market segment) influences on appreciation, preliminary analyses indicate that home prices are negatively correlated with appreciation (lowered value homes have higher appreciation rates), that the existence of new housing construction within specific market segments decreases the appreciation rates of existing homes, and that government sponsored mortgages have a positive impact on appreciation.

Understanding variations in single-family housing value appreciation both over time and spatially is of interest to homeowners, realtors, lenders, state and local governments, and public policy practitioners. In the immediate future it is expected that this information will be used by mortgage lenders and homeowners to evaluate the feasibility of mortgage modifications and/or re-financings in order to minimize foreclosures.

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1. BACKGROUND

1.1 Alternative Approaches to Estimate Housing Price Appreciation

A consensus has yet to emerge from the literature regarding the best methodology for measuring the price application of single family homes. The most simplistic approach which is regularly used in press releases by the National Association of Realtors is to report price appreciation based on average price trends (either means or medians) using a formula such as:

$$Appreciation = \frac{P_t - P_{t^*}}{P_{t^*}}$$

where t^* is the first period in a sequence and t is the year immediately following t^*.

Another frequently used methodology for calculating changes in real property value by researchers and the Federal Government agencies including the Office of Federal Housing Enterprise Oversight (OFHEO) is the repeat-sale methodology put forth by Bailey, Muth, and Norse (1963). The approach was further refined and developed by Case and Shiller (1987) and numerous other researchers have since developed strategies for dealing with problems the approach has in relation to heteroskedasticity, temporal effects, non-constant housing quality, and spatial effects (Quercia et al. 2000; Shiller, 1991).

A generic specification of the repeat-sale model is:

$$(\ln P_t - \ln P_{t^*}) = \sum_{i=1}^{n} \delta_t D_{it} + \varepsilon$$

regressing the difference in logged prices of the second and first sales against a matrix of time variables equal to -1 if the home sold for the first time in that year, equal to 1 if the home sold for the second time in that year, and 0 otherwise. These dummy year coefficients are interpreted as the logged price index.

A third technique for estimating price appreciation is through hedonic price modeling. The hedonic model was first developed theoretically by Rosen (1974) and is widely used by economists to quantify the determinants of real estate prices through multiple regression modeling with a particular emphasis on measuring the marginal impact of particular housing and/or land characteristics on price while holding other influencing factors constant. Crone and Voith (1992) use hedonic price modeling to explicitly measure housing appreciation through the inclusion of dummy variables accounting for the time period of sales. A generic form of such a model is:

$$\ln P = \beta_0 + \sum_{i=1}^{n} \beta_j X_{ij} + \delta_t D_{it} + \varepsilon$$

where X is a vector of housing characteristics, and D is a matrix of binary variables equal to 1 if the home sold in time t and 0 if otherwise. The time-dummy variables measure the cumulative change in price up to the year of the sale.

Most of the price appreciation literature has relied on variations of the repeat-sale methodology while one study in particular (Crone and Voith, 1999) has attempted to evaluate differences between methods by examining resulting prediction errors across models. They conclude that parametric approaches (repeat-sale and hedonic modeling) perform better than non-parametric approaches; however, no clear evidence yet exists to definitively rank the quality of hedonic versus repeat-sale approaches.

Wang and Zorn (1997) evaluate the underlying strengths and weaknesses of different appreciation estimation methods using a theoretical approach. They demonstrate that the repeat-sale method often omits key housing and neighborhood characteristics that may be influencing appreciation. Shiller (1991) also demonstrated that the repeat-sale usually under predicts appreciation (in comparison to other approaches) since it inherently uses geometric means rather than arithmetic means to estimate appreciation.

Case et al. (1991) discuss the limitation of small sample sizes associated with repeat-sale as only homes that have sold at least twice are utilized, and the fact that that the method does not account for increasing ages of homes over time, and that it may suffer in reliability with non-constant house quality among some repeat-sale.

Hybrid approaches for estimating appreciation which combines repeat-sale and hedonic approaches have been promoted and used with mixed success by Case, Pollakowski, and Wachter (1991), and Meece and Wallace (1997). While improving the amount of detail on housing characteristics and avoiding omitted variable bias, the hybrid approach still suffers from the relatively low sample sizes associated with the repeat-sale approach. To deal with this small sample problem associated with appreciation estimates for small areas (i.e. tracts), a repeat-sale based approach has been put forth by McMillen (2003) that constructs smooth precise indices (using a Fournier expansion model) and by accounting for sales nearby but outside of tracts.

Numerous studies including Archer et al., (1996), Goetzman & Spiegel (1997), Crone and Voith, 1999, Quercia et al. (2000), McMillen (2003), and Case et al., (2004) have all noted that appreciation rates tend to vary spatially which negates the reliance on single (citywide) appreciation. Most researchers estimating sub-market appreciation rely on the census tract as the unit of analysis. Variations in census tract boundaries for evaluating housing price sub-markets based on traditional hedonic price indices have been evaluated by Goodman and Thibodeau (2007)) while McMillen (2003) treated sold homes outside of the actual borders of tracts (but in close distance) while using a repeat-sales approach to estimate tract appreciation.

1.2. Summary of a Previous Study to Evaluate the Most Accurate Strategies to Estimate Housing Value Appreciation in Omaha (2000-2005)

A prior study was conducted by Shultz, Schmitz and Sindt (see Shultz and Schmitz, 2007 and Schmitz, Shultz and Sindt, 2008) in order to evaluate the most appropriate way to estimate single-family housing price appreciation in Omaha. This involved estimating price appreciation over the 2000 to 2005 period using both non-parametric and parametric approaches (repeat-sale and constrained hedonic models) and the estimates were made: citywide, for 35 pre-specified multiple listing service (MLS) neighborhoods, by 10 market segments based on clustering homes based on size and age in conjunction with road and other geographical boundaries, and for 177 census tracts. Comparisons of the different approaches and levels of analysis are made with respect to available sample sizes and the reliability of appreciation estimates (defined by the ranges of appreciation estimates, and the statistical significance of specific estimates). For all approaches, appreciation was calculated without the inclusion of new homes since the research objective to quantify the determinants of appreciation citywide and, in particular, in low-income neighborhoods in Omaha (i.e. the older parts of the city with fewer if any new housing starts).

Price appreciation in this study was calculated empirically citywide using variations of three methods. First, non-parametric estimates were made using both means and median price differences across years both with and without the inclusion of new homes (using Equation 1). Second, repeat-sale models (based on equation 2) were estimated with the changes in logged prices being regressed against a matrix of dummy variables equal to -1 if the home was sold first in time period t; equal to 1 if the home was sold for a second time in time period t, and 0 otherwise. A variation of this approach was also evaluated: the removal of repeat-sales if they were held (sold) for a period of less

than two years. Despite reducing the number of sales available for analysis, this approach has been used successfully in other price appreciation studies (Quercia et al., 2000) and has the advantage of excluding non-constant quality homes (i.e. homes that are purchased, extensively renovated and then quickly re-sold). Finally, a constrained hedonic model was estimated (equation 3) where structural and environmental characteristics of housing are *not* allowed to vary over time and appreciation is measured by a matrix of dummy variables equal to 1 if the sale was made in time period t. Continuous variables in the hedonic model included lot and house size, age of the home, and the number of garage stalls and bathrooms.

To evaluate potential spatial and temporal variations in housing price appreciation, appreciation using a non-parametric method, and constrained hedonic approaches was estimated citywide and at three more specific levels of geographical analysis: by already established MLS regions (n=35), by neighborhood market segments created through GIS-based clustering of homes based on size and age in conjunction with road and other geographical boundaries (n=10)**,** and by census tracts (n=177). The magnitude and range of appreciation rates across the alternative level of geographical analysis are compared to citywide estimates using both summary tables and maps. In particular, comparisons of the different approaches and levels of analysis are made with respect to available sample sizes and the reliability and consistency of appreciation estimates as measured by the standard deviations and ranges of appreciation, and the statistical significance of appreciation coefficients.

The results of the study clearly demonstrated that price appreciation for single-family housing varied substantially across Omaha which negated the use of a single (citywide) price appreciation estimate for planning and policy activities and/or for research intended to understand the various factors influencing appreciation. This study

also demonstrated that particular methodologies chosen for estimating appreciation (non-parametric versus repeat-sale or hedonic modeling) greatly influences appreciation estimates for specific neighborhoods, and that the chosen geographic level of analysis is also highly relevant. Specifically, hedonic regression modeling was shown to be superior over the repeat-sale and non-parametric approaches.

2. METHODS AND PROCEDURES

All multiple listing service (MLS) transactions recorded by the Omaha Area Board of Realtors in the Greater Omaha area (excluding Council Bluffs) over the 2000 to 2008 period were geographically referenced based on parcel identification numbers, county parcel coverages, and in some cases address matching. Housing parcel data from the county tax assessor records covering the same time period was also obtained and integrated with the MLS sales data in order to verify the accuracy of MLS data and to evaluate whether there were any statistically significant differences between MLS and non-MLS (i.e. for sale by owner homes). All homes were dropped from the analyses that were condominiums or townhomes, were part of an acreage (lots greater than 1 acre in size), homes in the 100-year floodplain, homes that were missing (or had erroneous) key missing information, and homes with sale prices that were less than $20,000 or greater than $525,000. The resulting sample consisted of 64,300 sales.

A constrained hedonic model was estimated (similar to equation 3) where structural and environmental characteristics of housing are *not* allowed to vary over time and appreciation is measured by a matrix of dummy variables equal to 1 if the sale was made in time period t. Continuous variables in the hedonic model include lot and house size (using several combinations of square feet variables), age of the home, and the number of garage stalls and bathrooms. Dummy variables are used to represent house

style (1, 1.5, 2, split and multi-story home styles) and to account for the existence of fireplaces and walk-out basements. The dummy variables of vector *D* are equal to 1 if the home sold in time t and 0 if otherwise. Unlike Crone and Voith's model which measured the appreciation for each year, this model measures the cumulative change in price up to the year of the sale. In this study we are interested in the coefficient of the year 2008 variable to measure total appreciation over the 2000 to 2008 period.

The hedonic price model was first estimated citywide using a series of dummy variables representing twelve general geographic regions (market segments). These geographic regions were created by whether or not a home was in the Millard or Westside school districts, as well as city/county boundaries, and homogenous housing stock. The hedonic model was then estimated separately for each of these 12 general market segments and then again for 38 smaller and more detailed market segments again based on school districts, city/county boundaries, and homogenous housing stock.

In all cases the amount of variation in housing prices explained by the models are evaluated (R^2 values and F-statistics) as well as the statistical significance of the explanatory variables (using t-tests) and their signs (impacts on housing prices). Only statistically significant appreciation estimates (based on time/dummy variables) are reported.

Finally, appreciation estimates are estimated across homes of different price ranges, in areas with varying levels of new home sales, and by conventional versus government sponsored mortgages in order to generate preliminary estimates of the factors influencing appreciation rates of single-family housing prices.

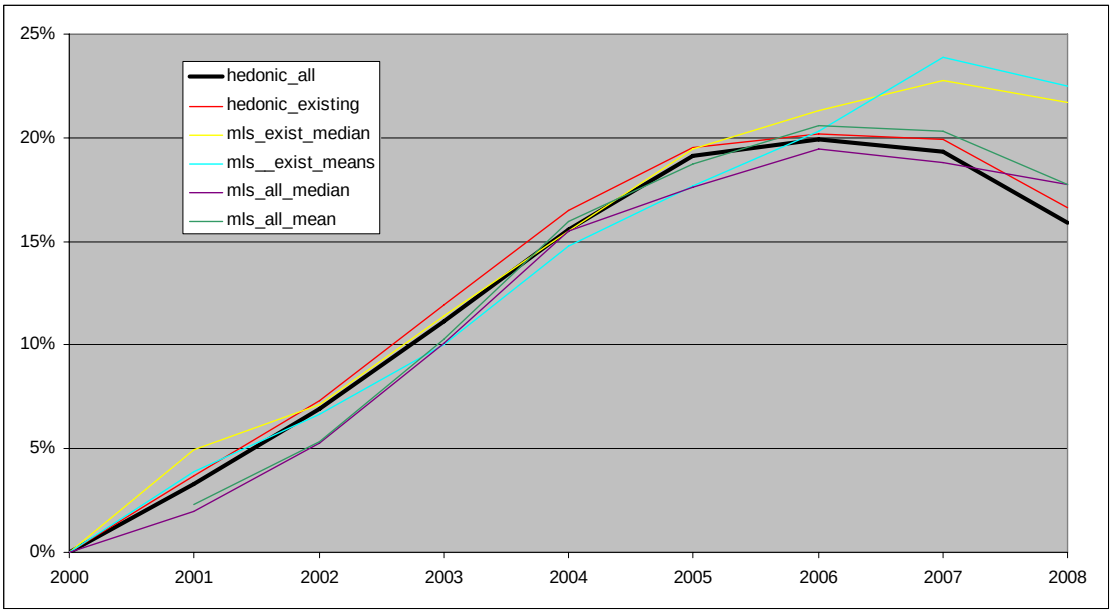
3. RESULTS

3.1. Omaha-wide Appreciation

The hedonic price model using all Omaha home sales has an R^2 value of .84 meaning that 84% of the variation in housing prices in Omaha is explained by the 30 explanatory variables in the model. Similarly the model has an F-statistic of 1,194 which is statistically significant at the 99% confidence level. All of the explanatory variables with the exception of one housing style variable are statistically significant at the 99% confidence level and all have their expected signs (impacts on housing prices). The coefficients on the time (dummy) variables indicated that between 2000 and 2008 housing prices (while accounting for different structural and location characteristics of sold homes) increased by 15.9% or on average 2% per year. During the 2000 to 2006 time period, appreciation was positive in each consecutive year (averaging 3.3% per year), but as shown in Figure 1, over the 2006 to 2008 period housing prices decreased by 4% (0.7% in 2007 and 3.3% in 2008).

Figure 1 also contains the appreciation rates over time (line-graphs) associated with 5 alternative measures: a hedonic model using only existing homes, and simple mean and medians with and without the exclusion of new homes. From this it can be seen that the hedonic model with all sales (denoted with a black dark line) tends to be in the middle of the range of appreciation estimates over the 2000 to 2006 time period but that over the 2006 to 2008 time period, it generated appreciation estimates that are lower (more negative) than any of the alternative measures. It is also interesting to note that both the hedonic and median/MLS appreciation measures which are based only on existing housing sales over the 2006 to 2008 period substantially over-estimate appreciation which indicates that the price declines of the new construction homes has been higher than with existing homes (at least in the last two years).

Figure 1. Omaha Housing Price Appreciation, 2000:2008
(Hedonic Versus Mean/Median Models)*



** Based on analyses of 65,000 sales but excluding condominiums, townhomes, or floodplain homes, acreages, or homes sold for less than $20,000 or more than $525,000. 'All' refers to both existing and new housing sales while 'Existing' refers to only existing home sales*

3.2 Appreciation Across 12 Generalized Market Segments

The hedonic price models estimated separately for each of the 12 generalized market segments have R^2 values ranging from of .42 to .90 with a median R^2 value of .88. All of the F-statistics are statistically significant and all of the time trend variables used to measure annual appreciation rates are statistically significant at the 99% confidence level. Between 2000 and 2008 appreciation ranged from 10.7% (1.3% per year) in the far northern part of Omaha to 20% (2.5% per year) in Bellevue (Table 1 and Figures 2 and 3). During the 2000 to 2006 time period, appreciation ranged from 15.6% (2.6% per year) in the Northwest region to 22.4% (3.7% per year) in the Far North section of Omaha. From 2006 to 2008, appreciation ranged from -11.7% in the Far North area to -1.9% in the Far West.

Figure 2. Price Appreciation in 12 General Market Segments
(Based on Hedonic Price models with all sales and R^2 values from .56 to .90)

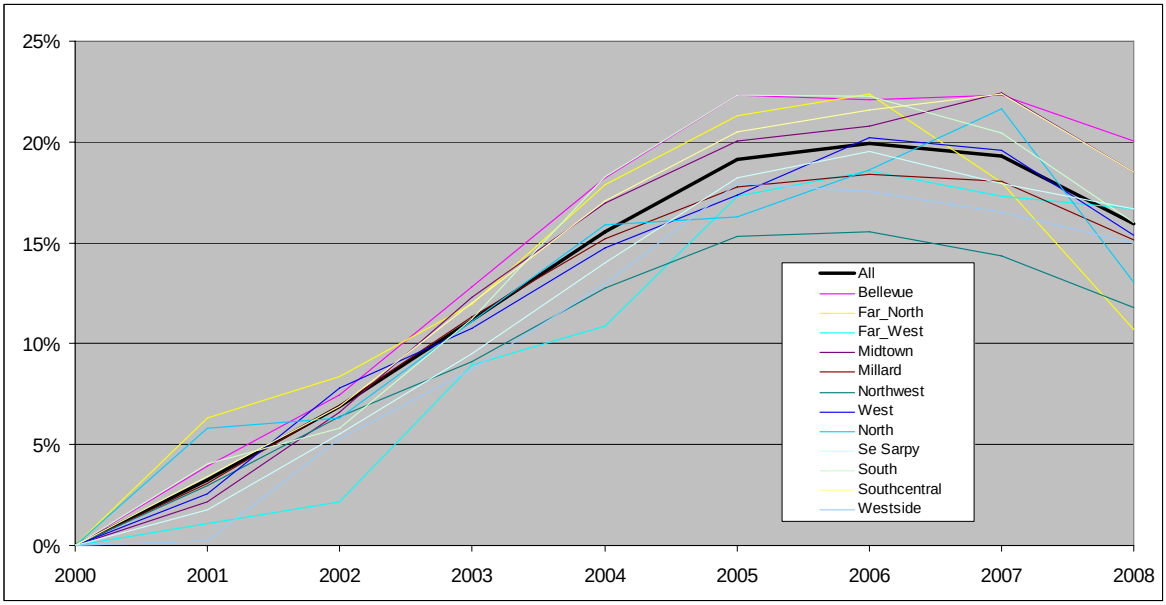
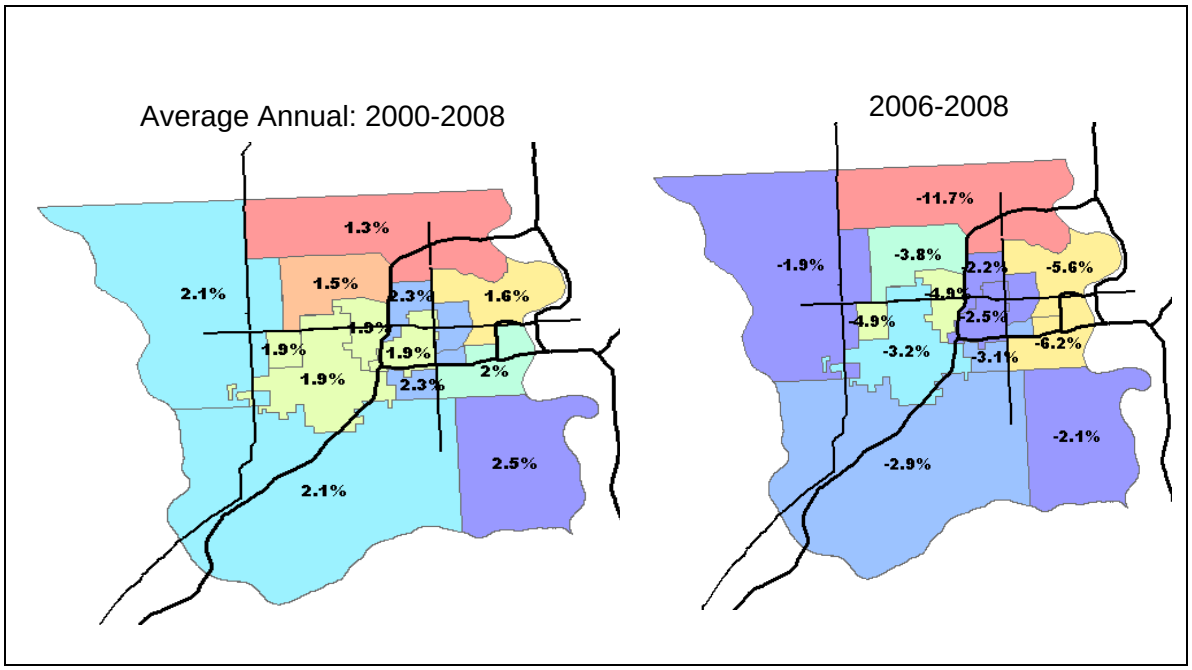


Table 1. Single Family Housing Price Appreciation & Depreciation Across Omaha
(Hedonic Price Models within 12 General Market Segments 2000-2008)*

	2000-08	2000-06	2006-2008
All of Omaha	15.9%	19.9%	-4.0%
Bellevue	20.0%	22.1%	-2.1%
Far_North (north of Fort/Sorenson)	10.7%	22.4%	-11.7%
Far_West (Douglas County, West of 180/192 streets)	16.7%	18.5%	-1.9%
Midtown (east of Saddle Creek)	18.5%	20.8%	-2.2%
Millard (school district)	15.1%	18.4%	-3.2%
Northwest (I-680 to 180 St, South of Ida)	11.8%	15.6%	-3.8%
West (I-680 to 192 St)	15.4%	20.2%	-4.9%
Northeast	13.1%	18.6%	-5.6%
SE_Sarpy	16.7%	19.6%	-2.9%
South (east of 50th street and north of Harrison)	16.0%	22.3%	-6.2%
Southcentral	18.5%	21.6%	-3.1%
Westside School District	15.0%	17.5%	-2.5%

** Based on Hedonic Price modeling of 65,000 sales (including new housing sales) while controlling for structural housing characteristics. The sample does not include condominiums, townhomes, or floodplain homes, acreages, or homes sold for less than $20,000 or more than $525,000. See the accompanying map.*

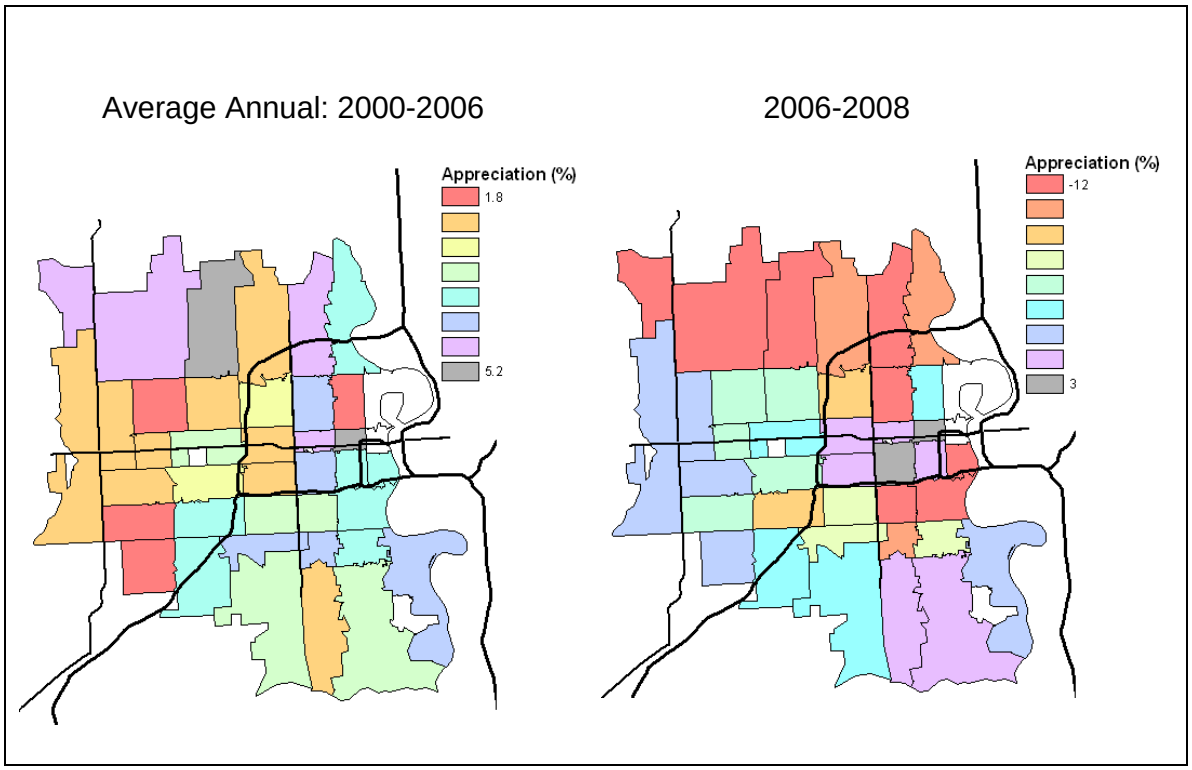
Figure 3. Maps of Price Appreciation in 12 General Market Segments



3.3 Appreciation Across 37 Detailed Market Segments

It was possible to generate statistically significant hedonic based appreciation estimates for 37 of the 39 detailed market segments used to represent the Omaha housing market. The two areas for which statistically significant appreciation measures were not estimated are the North Omaha/Carter lake area near the airport and the downtown area. The hedonic price models for each of the remaining 38 models have R^2 values ranging from .46 to .96 with a median R^2 value of .92. All of the F-statistics are statistically significant and all of the variables on the appreciation variables are statistically significant at the 99% confidence level. Between 2000 and 2008 price appreciation ranged from 8% (1% per year) in an area of North Omaha to 34% (4.2% per year) in a midtown neighborhood. From 2000 to 2006 appreciation ranged from 13.2% to 31.3% (1.8% to 5.2% per year) and finally, from 2006 to 2008, appreciation ranged from -12% (a far North Omaha area) to 3.0% in a midtown neighborhood (see Figure 4).

Figure 4. Maps of Price Appreciation in 37 Detailed Market Segments



3.4. Factors Influencing Appreciation

Hedonic regression models were estimated under alternative criteria in order to generate preliminary estimates of the factors influencing appreciation in the Omaha market over the 2000 to 2008 period. First, lower priced homes had higher appreciation rates than higher priced homes. This finding is likely driven by the inventory of homes in different price ranges in the Omaha market and/or difficulties in obtaining financing for more expensive homes. Second, areas containing higher percentages of new housing construction have lower appreciation rates (for existing homes) than areas with lower quantities of new housing sales which again, is related to housing supply issues and the fact that existing home sales often have to compete with new housing construction. Finally, homes purchased with government subsidized mortgages experienced higher appreciation rates over the 2000 to 2008 time period compared to homes purchased with conventional mortgages. This is most likely a result of the government sponsored

mortgage products having stricter underwriting requirements (and fewer subsequent foreclosures) compared to conventional loan classifications which are likely to include some sub-prime loans.

It should be pointed out that these findings regarding factors influencing appreciation rates are based on Omaha-wide housing sales and these relationships are likely to vary substantially across different neighborhoods (as do appreciation rates). As well, a more reliable analysis of the factors influencing appreciation would require multivariate regression analyses where appreciation within individual market segments are regressed against housing characteristics and demographic data. Such analyses are ongoing by staff at UNO Real Estate Research Center.

4. SUMMARY AND FUTURE RESEARCH

Understanding variations in single-family housing price appreciation both over time and spatially is likely to be of interest to homeowners, realtors, appraisers, lenders, state and local governments, and public policy practitioners. This research has generated accurate housing price appreciation estimates across Omaha over time and has demonstrated the need for such estimates across different geographical market segments.

When there is not enough time or financial resources to conduct complete (traditional) appraisals of individual homes, the market segment appreciation estimates reported in this study and/or the use of estimated multiple regression coefficients from different hedonic models can potentially be used to ***estimate (not appraise)*** the current approximate market value of home if the home in question was: purchased over the 2000 to 2007 time period, had an original sale price that was reflective of the market at the time it was purchased , and if it has not been subject to major physical changes (either negative or positive) since the time it was first purchased.

These rapid and low cost (potentially free) valuations could potentially be used by mortgage lenders and/or homeowners in evaluating the feasibility of re-negotiating and/or refinancing the terms of underwater mortgages to avoid foreclosures. This could be accomplished by two alternative approaches. First the original sale price of previously sold home (over the 2000 to 2007 time period) could be multiplied by year-specific appreciation rate (over the 2000-2008 time period) within a specific market segment. Alternatively, the characteristics of a particular home (features, style, and location) could be entered into the hedonic price models generated by this study to estimate a more house-specific estimate of its current value.

Finally, it is expected that information on the factors influencing appreciation could also potentially be used by government officials to promote or plan various public investments and/or subsidized mortgage programs. It is recommended however that estimates of the factors influencing single-family house appreciation be further refined in the form of multivariate regression analysis that includes additional demographic, infrastructure, amenity and other neighborhood specific data.

5. REFERENCES

Archer, W, D. Gatzlaf, and D. Ling. 1996. "Measuring the Importance of Location in House Price Appreciation." Journal of Urban Economics. 40 334-353.

Bailey, M., R. Muth, and H. Nourse. 1963. "A Regression Method for Real Estate Price Index Construction." *Journal of the American Statistical Association.* 58 933-942.

Case, B., J. Clapp, R. Dubin, and M. Rodriquez, 2004. Modeling Spatial and Temporal House Price Patterns: A Comparison of Four Models. *Journal of Real Estate and Finance Economics,* 29:2 167-191

Case, B., H.O. Pollakowski, and S.M. Wachter. 1991. "On Choosing Among House Price Index Methodologies." *AREUEA Journal.* 19(3) 286-307

Case, K. and R. Shiller. 1987. "Prices of Single Family Homes since 1970: New Indexes for Four Cities." *New England Economic Review.* Sep/Oct: 45-46.

Crone, T. and R Voith. 1999. "Estimating house price appreciation: A comparison of methods." *Journal of Housing Economics.* 2, 324-338.

Crone, T., and R. Voith. 1999. "Risk and Return Within the Single Family Housing Market." *Real Estate Economics.* 27(Spring) 63-78. 26

Goetzman & Spiegel (1997). "A Spatial Model of Housing Returns and Neighborhood Substitutability." *Journal of Real Estate Finance and Economics.* 14(1):11-31

Goodman, A. and T. Thibodeau, 2007. The spatial proximity of metropolitan area housing submarkets. *Real Estate Economics,* 35(7): 209-232.

McMillen, D. 2003. Neighborhood house price indexes in Chicago: A Fourier repeat-sale approach. *Journal of Economic Geography,* 2:57-73.

Quercia, R., G. McCarthy, R. Ryznar, and A. Talen. (2000). "Spatio-Temporal Measurment of House Price Appreciation in Underserved Areas." *Journal of Housing Research.* 11(1)

Rosen, S. (1974). "Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition." *The Journal of Political Economy.* 82(1) 34-35.

Schmitz, N. S. Shultz, and R. Sindt. 2008. Does a rising tide raise all ships? Single family housing value appreciation across Omaha (2000-2005). *Economics and Business Journal: Inquiries and Perspectives,* 1(1): 37-45.

Shiller, R. J. (1991). "Arithmetic Repeat-sale Price Estimators." *Journal of Housing Economics.* 1: 110-126.

Shultz, S. and N. Schmitz. 2007. "Modeling Neighborhood Level Price Appreciation: A Comparison of Methods and Levels of Spatial Scale". *American Real Estate and Urban Economics Association 35th Annual Mid-Year Meeting,* May, 2007. Washington DC.

Wang, F. T. and P. M. Zorn. (1997). Estimating House Price Growth with Repeat-sale Data: What's the Aim of the Game?" *Journal of Housing Economics.* 6 93-118.