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Monthly rental price of a comparable home and the pricing of a two-bedroom home

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ABSTRACT

Using single and multivariate OLS regressions, this study examines how the listing price of a two bedroom home is affected by the monthly rental price of a comparable home in the same city. We do this in order to provide some direction to young families looking to purchase their first home. Our data encompasses each state's most populated city within the United States. This study reveals that as the monthly rental price of a comparable home (especially condos) increases, and/or as the price-to-rent ratio increases, so does the listing price of a two bedroom home. Therefore, a frugal home buyer should keep an eye on both comparable rental prices, and on the price-to-rent ratio within their city of interest. When rental prices drop, or when the price-to-rent ratio decreases, that is when a homebuyer should begin to consider the purchase of a two-bedroom home.

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1. Introduction

The purpose of this study is to predict the price of a two bedroom home located in one of the United States' most populated cities[1]. Specifically, we wish to see how the listing price of a two bedroom home is affected by the monthly rental price of a comparable home[2] in the same city.

Our specific choice of real-estate (two bedroom home) and location (major United States city) fits the needs of our target purchaser: a young family[3] looking to plant roots in a metropolis where job opportunities are abundant[4]. This family can either be moving from a non-major city within the United States, or coming from a different country. We have decided to focus on renting versus purchasing because a large down payment, or insufficient credit history, may prevent a young family from purchasing a home, and therefore renting versus purchasing becomes a legitimate decision.

2. Data selection

To predict how the listing price of a two bedroom home is affected by the monthly rental price of a comparable home in the same city, we began by extracting data from Zillow's online database (Zillow, 2016). Zillow's database included real estate data for the majority of cities throughout the United States, measuring

[1]To encompass the United States' most populated cities, our study focused on the top populated city for each state.
[2]Comparable home: an accommodation that is either two bedroom or similar in size.
[3]Young family: a domestic partnership or newlywed couple, with no more than one child under the age of thirteen.
[4]The abundance of jobs must take location into consideration. For example, Anchorage, Alaska may not be teeming with jobs; however, in respect to other Alaskan cities, the number of job opportunities is fairly high.

multiple spectrums such as listing price, rental price, and changes in home value. The variables we selected for our analysis are shown in Table 1.

Table 1: Selected variables

Dependent variable (per city of interest)	
Med_LstP_2B	The median listing price of a two bedroom home.
Explanatory variables (per city of interest)	
Med_RnP_1B	The median rental price per month of a one bedroom home.
Med_RnP_2B	The median rental price per month of a two bedroom home.
Med_RnP_3B	The median rental price per month of a three bedroom home.
Med_RnP_Condo	The median rental price per month of a condo.
PR_Ratio	The price-to rent-ratio for all homes. The price-to rent-ratio is defined as the median listing price for all homes, divided by twelve times the median monthly rental price for all similar homes. The lower the ratio, the smaller the gap between rental costs and listing prices, and therefore the decision to buy a home versus renting a similar one becomes more attractive (Humphries, 2010).
Inv_Measure	The inventory measure. The inventory measure is defined as the number of single-family, condominium and cooperative housing units for sale. This data has been smoothed and seasonally adjusted.
Incr_Val050; Incr_Val5070; Incr_Val7090; Incr_Val90100	The percentage of homes increasing in value (expressed as four dummy variables).[5]

There are three important details worth noting about our data. First, for all variables, we used the average of the twelve month period spanning April 2015 to March 2016. Second, as previously noted, our data focused on the one most populated city of each state. Third, due to data availability, we have omitted four states: Maine, North Dakota, Vermont, and Wyoming. Therefore, our sample size is forty-six rather than fifty.

3. Descriptive statistics

Table 2 provides the mean, standard deviation, minimum and maximum for both our dependent and explanatory variables.

Table 2: Summary statistics

Variable	Observations	Mean	Standard Deviation	Minimum	Maximum
Med_LstP_2B	46	208574.50	154271.40	71545.83	761625.00
Med_RnP_1B	46	1013.35	438.00	450.00	2257.08
Med_RnP_2B	46	1224.56	563.00	647.92	2603.75
Med_RnP_3B	46	1437.67	629.45	750.00	3426.58
Med_RnP_Condo	46	1391.65	544.70	659.79	3166.25
PR_Ratio	46	10.91	3.58	4.23	20.14
Inv_Measure	46	2402.11	3031.17	35.92	17669.83
Incr_Val50	46	0.239	0.431	0	1
Incr_Val5070	46	0.500	0.506	0	1
Incr_Val7090	46	0.196	0.401	0	1
Incr_Val90100	46	0.065	0.250	0	1

Interestingly, the maximum listing price of a two bedroom home is roughly *ten* times the minimum listing price; however, the maximum rental price for all units is roughly *five* times the minimum rental price. Therefore, one could argue that the housing price disparity across states is greater for purchasing a home than it is for renting one.

To capture the pricing differences across cities, figure 1 graphs each city's listing price for a two bedroom home. The cost of housing in New York, New York is substantially greater than that of the United States' other major cities (roughly 30% more expensive than its predecessor, Boston, Massachusetts); therefore, it is on the verge of becoming an outlier[6].

[5]For more on our dummy variables, see table 4.

[6]For more on outliers, see our section titled OLS Assumptions & Limitations.

Figure 1: Listing price of a two bedroom home

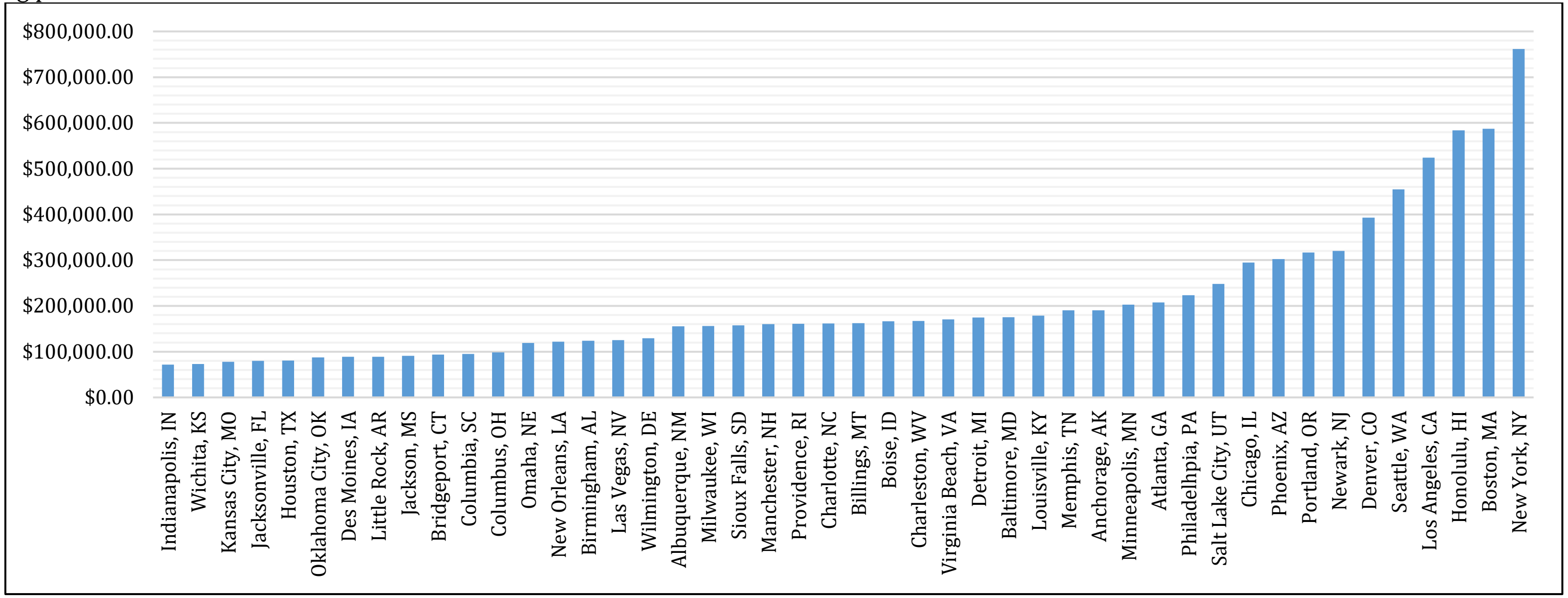


Table 3: Explanatory variable correlation

	Med_RnP_1B	Med_RnP_2B	Med_RnP_3B	Med_RnP_Condo	PR_Ratio	Inv_Measure	Incr_Val50	Incr_Val5070	Incr_Val7090	Incr_Val90100
Med_RnP_1B	1.000									
Med_RnP_2B	0.951	1.000								
Med_RnP_3B	0.872	0.950	1.000							
Med_RnP_Condo	0.878	0.868	0.864	1.000						
PR_Ratio	0.630	0.711	0.754	0.606	1.000					
Inv_Measure	0.460	0.398	0.369	0.443	0.274	1.000				
Incr_Val50	-0.341	-0.282	-0.301	-0.179	-0.390	-0.141	1.000			
Incr_Val5070	0.038	-0.055	-0.082	-0.041	-0.005	0.063	-0.561	1.000		
Incr_Val7090	0.135	0.156	0.207	0.135	0.298	0.045	-0.277	-0.493	1	
Incr_Val90100	0.294	0.346	0.353	0.174	0.205	0.044	-0.148	-0.264	-0.130	1

4. Data discussion and model specification

4.1 Data discussion

As seen in table 1, to account for housing that is comparable to a two bedroom home, we included the monthly rental price of a one bedroom home, two bedroom home, three bedroom home and condominium, under the assumption that these are realistic alternatives to purchasing a two bedroom home. To further capture the difference between purchasing and renting, we included the price-to-rent ratio for all homes. Additionally, we added two explanatory variables to sketch the health of each city's real estate market. These included each city's inventory measure, and percentage of homes increasing in value.

Our decision to include these variables were not only to account for rental costs and to measure the health of each city's real estate market, but also to alleviate omitted variable bias. Our regressors help us to alleviate omitted variable bias for two reasons. Each of them, intuitively, are "a determinant of the dependent variable", and all of them are correlated with at least one other regressor, as shown in table 3 (Stock & Watson, 2015).

Moving on, as shown earlier in table 1, our explanatory variable explaining "the percentage of homes increasing in value" was transformed into four dummy variables, now explained in table 4.

Table 4: Percentage of homes increasing in value (per city of interest)

Incr_Val050	0 ≥ [% of homes increasing in value] < 50%	Indicator = 1 if the percentage of homes increasing in value is greater than or equal to 0%, but less than 50%. Otherwise indicator = 0.
Incr_Val5070	50 ≥ [% of homes increasing in value] < 70	Indicator = 1 if the percentage of homes increasing in value is greater than or equal to 50%, but less than 70%. Otherwise indicator = 0.
Incr_Val7090	70 ≥ [% of homes increasing in value] < 90%	Indicator = 1 if the percentage of homes increasing in value is greater than or equal to 70%, but less than 90%. Otherwise indicator = 0.
Incr_Val90100	90 ≥ [% of homes increasing in value] ≤ 100%	Indicator = 1 if the percentage of homes increasing in value is greater than or equal to 90%, but less than or equal to 100%. Otherwise indicator = 0.

These four dummy variable "buckets" indicate the strength of the housing market. The higher the percentage of homes increasing in value, the stronger the housing market per city. For our analysis, in order to avoid perfect multicollinearity, we will drop the fourth bucket representing 90 ≥ [% of homes increasing in value] ≤ 100%. We chose this bucket because it represents the least amount of cities[7].

4.2 OLS assumptions and limitations

Our project attempts to follow the four ordinary least squares (OLS) assumptions for multivariate regression (Stock & Watson, 2015). The first OLS assumption states that the conditional distribution of the error term is expected to equal zero. Naturally, this is a fairly unrealistic assumption, and therefore our analysis is slightly limited in this sense; however, we have done our best to include a number of variables[8] that realistically capture the complete error term. Second, we attempted to keep our dependent and explanatory variables independently and identically disrupted. Nonetheless, the variables of our analysis were not particularly selected independently (i.e. randomly). In order to pinpoint specific cities (those most populated per state), we "cherry-picked" specific cities, and therefore our analysis was not random. However, our variables were identically distributed (e.g. all coming from a single large population, the United States).

The third OLS assumption claims that "large outliers are unlikely" (Stock & Watson, 2015). The graphs in figure 2 plot the median listing price of a two-bedroom home on the y-axis, and the median monthly rental price of a one-bedroom home, two-bedroom home, three bedroom home, and condo on the x-axis (starting from the top left, going clockwise).

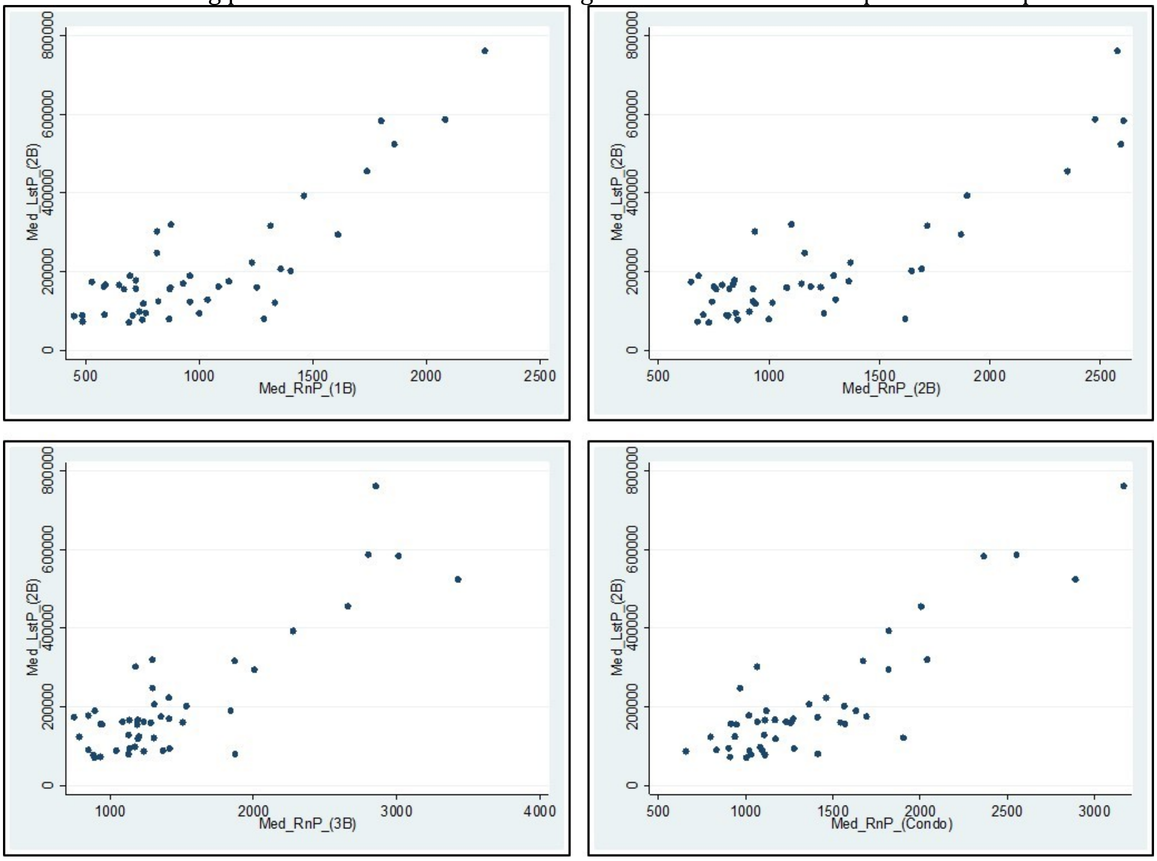
Based on figure 2, we argue that our data maintains the third OLS assumption[9]. As seen in figure 2, there are a few data points that are a bit "out there" (for example, New York, New York being at the far upper right of each graph); however, we have decided to include these points because they are relevant to the discussion at hand – we want to predict how the listing price of a two-bedroom home is affected by the monthly rental price of a comparable home in the same city *across the United States*, not within an isolated geography or city economy.

The fourth and final OLS assumption says that there can be no perfect multicollinearity. Our regression holds this assumption – no regressor is a linear function of another regressor (Wei, 2016). Regarding our complete

[7]Seattle, Washington and Denver, Colorado.
[8]This also aided our alleviation of omitted variable bias.
[9]Additionally, our data appears to be definitively linear.

set of dummy variables, as mentioned earlier, in order to avoid perfect multicollinearity we chose to drop the dummy variable representing 90 ≥ [% of homes increasing in value] ≤ 100%.

Figure 2: Median listing price of a two bedroom home against the median rental price of a comparable home



Aside from our OLS assumptions, there are two important limitations worth noting. First, our sample size of forty-six is rather small; therefore, we do not gain the statistical benefits of a large sample size such as data variability. Second, even though each city is the most populated of its' state, they all have meaningfully different economies and living standards. In light of this, we are attempting to capture a significantly broad range of data, which is damaging because it becomes difficult to pinpoint a meaningful finding. However, that is the nature of our study; as mentioned earlier, we want to predict how the listing price of a two bedroom home is affected by the monthly rental price of a comparable home in the same city *across the United States*, not within a geographically isolated economy.

4.3 Model specification

We use OLS single and multivariate regression analysis to predict how the listing price of a two bedroom home is affected by the monthly rental price of a comparable home in the same city, paired with the health of the real estate market for that city.

Our dependent variable is always the median listing price of a two bedroom home, and the explanatory variables that we use vary with our analysis.[10] Robust standard errors are used in each equation in order to control for heteroscedasticity. With all variables included, our regression builds as follows:

$$\left[\begin{array}{c} Med\_LstP\_2B = \beta_0 + \beta_1(\mathrm{Med\_RnP\_1}B) + \beta_2(\mathrm{Med\_RnP\_2}B) + \beta_3(Med\_RnP\_3B) + \beta_4(Med\_RnP\_Condo) \\ + \beta_5(PR\_Ratio) + \beta_6(Inv\_Measure) + \beta_7(Incr\_Val050) + \beta_8(Incr\_Val5070) + \beta_9(Incr\_Val7090) \end{array}\right]$$

5. Data analysis and results

Table 5 presents the results of our regression. According to regressions (1) through (4), the monthly rental price of a residence comparable to a two-bedroom home is a reasonable measure of a two-bedroom home's listing price – at least when used as a single variate regression. For each of our first four regressions, as the monthly rental price of a comparable home increases by one dollar, the listing price of a two-bedroom home increases by an amount in the \$200 to \$300 dollar range. However, as shown in regressions (5) through (8), when the prices of our four comparable living spaces are simultaneously used to determine our listing price, the majority

[10] For a detailed breakdown of specific variables used, see the table 5.

(aside from condos) become insignificant. However, even though regressions (5) through (8) are fairly insignificant, both the rental price of a condo and the price-to-rent ratio stay consistently significant at the 99% level.

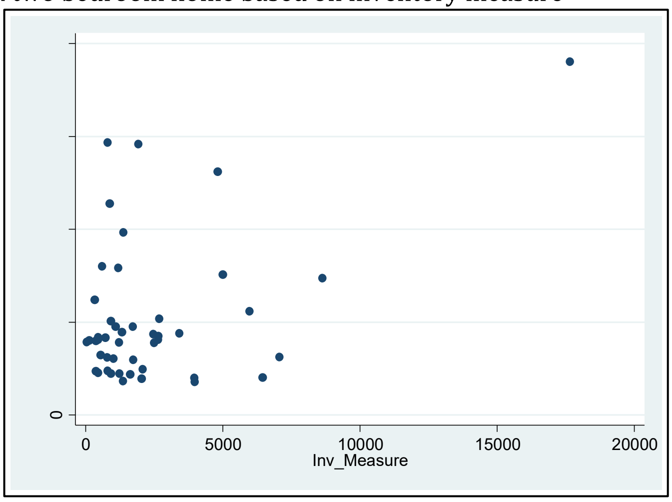
Table 5: Regression results

Dependent variable: *Med_LstP_2B*								
Regressor	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Med_RnP_1B	289.9071**				- 65.61	- 47.49	- 67.82	- 81.71
(X_1)	(38.34)				(106.85)	(115.12)	(119.97)	(132.81)
Med_RnP_2B		235.26**			127.00	106.82	119.03	134.57
(X_2)		(27.42)			(115.48)	(117.45)	(114.13)	(123.37)
Med_RnP_3B			209.44**		29.81	- 52.06	- 52.42	- 51.87
(X_3)			(27.09741)		(55.08)	(48.95)	(48.12)	(51.66)
Med_RnP_Co				246.42**	149.11**	166.70**	161.73**	160.65**
ndo (X_4)				(26.00)	(48.17)	(41.64)	(40.21)	(41.55)
PR_Ratio (X_5)						17435.19**	17252.13**	16479.19**
						(3880.384)	(3820.37)	(3772.42)
Inv_Measure							3.84	3.80
(X_6)							(4.07)	(4.23)
Incr_Val050								12839.06
(X_7)								(57310.37)
Incr_Val5070								22530.24
(X_8)								(51776.08)
Incr_Val7090								22849.52
(X_9)								(54910.2)
Intercept	- 85201.84*	- 79509.59**	- 92526.69**	- 134357.5**	- 130806.8**	- 221414.7**	- 215548.6**	-230043.7**
	(35124.57)	(30459.62)	(35202.96)	(33154.48)	(38482.61)	(38653.71)	(35917.38)	77021.88
Summary Statistics								
MSER	88602	79997	81033	76909	71089	57697	57411	59380
R^2	0.6775	0.7371	0.7302	0.7570	0.8065	0.8757	0.8800	0.8815
n	46	46	46	46	46	46	46	46

*The individual coefficient is statistically significant at the 5% significance level using a two-sided test.
**The individual coefficient is statistically significant at the 1% significance level using a two-sided test.

We were curious, as shown in regressions (5) through (8), why do the majority of comparable rental spaces become insignificant when used simultaneously? As an intuitive answer, it would not make sense to use the monthly rental prices of all comparable units to predict the single listing price of a two-bedroom home, especially when one comparable unit (i.e. condos[11]) is a more accurate predictor than others. Our inventory measure may be insignificant simply because the distribution, as shown in figure 3, is non-linear and contains a large outlier.

Figure 3: Listing price of a two bedroom home based on inventory measure



[11]Single variate regressions (1) through (4) revealed that condos, when used as our explanatory variable for the listing price of a two bedroom home, delivered the lowest standard error, MSER, and highest r-squared.

Moving on, we found it rather odd that our binary buckets expressing the percentage of homes increasing in value were proven insignificant in regression (8). Intuitively, the health of the housing market should be a strong determinant of housing prices. As shown in table 7, they proved insignificant even as a stand-alone multivariate regression explaining the price of a two bedroom home.

Table 7: Regression results

	Dependent variable: *Med_LstP_2B*
Regressor	(10)
Incr_Val050 (X_7)	- 177008.4
	(101527.8)
Incr_Val5070 (X_8)	- 103274.4
	(104663.2)
Incr_Val7090 (X_9)	- 36440.69
	(114668)
Intercept	309669.4**
	(99015.36)
	Summary Statistics
MSER	1.5e+05
R^2	0.1230
n	46

**The individual coefficient is statistically significant at the 1% significance level using a two-sided test.

In fact, even as tested single variate regressions, all but one[12] of our four binary buckets were insignificant. Our argument for this phenomena was that this statistic captured *all* homes[13] (not only two bedroom homes), which may or may not be increasing in value in that particular city.

6. Conclusions

According to our results, the purveyor who wishes to predict the price of a two bedroom home, based on the monthly rental payments of a comparable home in the same city, should either use one of the single variate regressions with monthly rental payments as the explanatory variable (expressed in regressions (1) through (4) in table 5); or multivariate regression (8), bearing only the rental price of a condo and the price-to-rent ratio into consideration as their significant explanatory variables. Generally speaking, multivariate regression (8) is the best estimator for our study primarily to alleviate omitted variable bias.

Conferring with our multivariate regression reveals that as the monthly rental price of a condo increases by $1.00 (holding all other variables constant), the listing price of a two bedroom home will increase by $160.65. Likewise, holding all other variables constant, as the price-to-rent ratio increases by one, the listing price of a two bedroom home will increase by $16,479.19.[14] Two additional, broad conclusions can be drawn from our analysis. First, if the rental price of a condo is going up, so is the listing price of a two bedroom home. Therefore, a frugal home buyer should keep an eye on the rental price of condos; when rental prices decrease, that is when they should consider purchasing a home. Second, as the price-to-rent ratio decreases[15], so will the price of a two bedroom home.

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[12]Incr_Val050 was significant at the 99% level.

[13]This added four bedroom homes, five bedroom homes, duplexes and triplexes.

[14]Vice versa for a decrease of one for each variable. As the monthly rental price of a condo decreases by $1.00 (holding all other variables constant), the listing price of a two bedroom home will decrease by $160.65. Likewise, holding all other variables constant, as the price-to-rent ratio decreases by one, the listing price of a two bedroom home will decreases by $16,479.19.

[15]Particularly the median listing price for all homes.