

## Estimating and Examining Movements in Housing Market Demand and Supply Indices

Revised Draft: August, 2010

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# **Estimating and Examining Movements in Housing Market Demand and Supply Indices**

Fisher, Gatzlaff, Geltner and Haurin

## **Abstract**

This study examines the magnitude and movements of alternative index measures for single-family housing. More specifically, the study estimates standard hedonic, selection-corrected hedonic and constant-liquidity (demand and supply) indices using a large dataset from a single state—Florida. Results indicate that standard hedonic estimates are selective; however, the magnitude of the correction is very small, especially at the statewide level. Changes in the constructed demand and supply indices are shown to vary each period from the selection-correction (and standard hedonic) measures; are correlated with key economic variables; and are found to precede inter-temporal changes in the value indices. The pattern of the differences is consistent with the notion that buyer reservation prices respond quicker (or greater) to new relevant information and that seller reservation prices appear to be “sticky.”

## **I. Introduction**

In some markets, the transaction price represents not only the value of an asset, but also aspects of the asset’s liquidity. Introducing liquidity to the discussion implies there is an underlying search process with asset buyers and asset sellers attempting to find a match. It also implies that not all assets sell at each point in time, which in turn introduces concepts such as time-on-market and the “ease of selling” an asset. While some aspects of search theory are well developed, its application to the asset market is less so, one piece of evidence being the continuing interest in the liquidity of assets. This ambiguity leads to key issues in the use of “measurement tools” associated with asset markets, including the development and our understanding of price indexes.

Fisher, Gatzlaff, Geltner and Haurin (FGGH, 2003) develop a method to estimate constant-liquidity indices and demonstrate the construction of such indices for the commercial property market using data from the National Council of Real Estate Investment Fiduciaries (NCREIF). This paper extends that work by first estimating standard hedonic, selection-corrected hedonic, and constant-liquidity (demand side) indices for single-family residential property using a large data set of sold and unsold observations. The characteristics of these alternative indices

are compared and evaluated. Finally, the deviations between changes in the constant-liquidity and selection-corrected are examined.

In general, we consistently find that state- and MSA-level price indices estimated using only sold properties are selective; however, the selection-corrected index adjustments are not large and the corrected indices do not typically differ substantially from standard hedonic price measures. However, state- and MSA-level constant-liquidity (e.g., demand-buyers') indices may differ from standard measures and their movements generally appear to lead the selection-corrected and standard hedonic measures. We report preliminary evidence that the movements in the constant-liquidity indices and the selection-corrected indices are strongly correlated with economic factors. For example, deviations between the demand and supply measures are found to be negatively correlated with unemployment rate, consistent with the idea that buyers' reservation prices respond quicker (or greater) than sellers' reservation prices to new relevant price information and that seller reservation prices are "sticky." Furthermore, changes in the demand and supply measures are correlated with subsequent price changes and consistent with the idea that the privately negotiated pricing mechanism of the housing market is less efficient than that of publicly-traded assets.

The study is organized as follows. In the next section, following FGGH 2003, we provide a model and discuss of the role of movements in buyers' and sellers' reservation price distributions in affecting transaction frequency and price movements. The data are described in section three and alternative indices estimated and examined in section four. This is followed by a conclusion.

## II. The Model

Fisher, Gatzlaff, Geltner and Haurin (FGGH; 2003, 2004) show that it is the relative movements of the potential buyers' and sellers' reservation price distributions that result in changes in transaction frequency and that the relative movements produce a pro-cyclic signature (see Figure 1). As economic activity increases, the buyers' reservation prices (left-hand distribution) move to the right farther than the sellers' which results in increased transaction frequency as shown by the larger area under the intersected distributions. In a down market the opposite condition occurs (see Figure 1, Panel C). The relative movements of the reservation prices are influenced by macro- and micro-level considerations. Transaction motivation may be affected by general market conditions and explain some of the variation over time in the flow of capital into and out of a particular housing market segment or location. Alternatively the motivation may be affected by an owner's decision to hold a particular property.

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Insert Figure 1 about here  
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FGGH, 2003, present a model of buyers and sellers that must form a match to complete a transaction. Over time (or over a market's cycle) this match process changes in ways that can be characterized by time-varying transaction volume and transaction prices. In their model of the search process, two equations characterize the buyers' and sellers' behaviors over time. With the two observed time series, sufficient information is available to solve for this characterization of buyers and sellers behaviors. The outcome is quite powerful. It can be used to develop a time series of the mean of buyers' reservation prices (and sellers'). Variations in transaction volume are explained by the interactions of these two distributions. Transaction volume expresses the ease of selling and the model allows constant-liquidity price series to be developed and buyers' and sellers' distributions to be estimated.

While a graphical depiction of the search process is illuminating, we present here only the backbone of the model (see FGGH, 2003 for a complete model). Assume Buyers' and sellers' reservation prices are:

$$RP_{it}^b = \sum \alpha_j^b X_{ijt}^P + \sum \beta_t^b Z_t + \varepsilon_{it}^b \quad (1)$$

$$RP_{it}^s = \sum \alpha_j^s X_{ijt}^P + \sum \beta_t^s Z_t + \varepsilon_{it}^s \quad (2)$$

where:  $RP_{it}^b$  = the natural logarithm of a buyer's reservation price for asset  $i$  as of time  $t$ , drawn from the buyers' distribution;  $\varepsilon_{it}^b$  = a normally distributed mean zero random error;  $RP_{it}^s$  = the natural logarithm of a seller's reservation price for asset  $i$  as of time  $t$ , drawn from the sellers' distribution;  $\varepsilon_{it}^s$  = a normally distributed mean zero random error;  $X_{ijt}^P$  = a vector of  $j$  asset-specific cross-sectional characteristics relevant to valuation; and  $Z_t$  = a time-dummy variable equal to 1 in year  $t$ , otherwise zero.

The differences between the  $\beta_t^b$  and  $\beta_t^s$  coefficients reflect the difference in the responsiveness of buyers and sellers to changes in the market. For example, if sellers adjust their reservation prices more slowly than buyers, then the changes in the  $\beta_t^s$  coefficients will tend to lag behind the changes in the  $\beta_t^b$  coefficients. The interaction of  $\beta_t^b$  and  $\beta_t^s$  over time produce both the empirically observed market-wide price movements and changes in transaction volume.

A transaction occurs if and only if the buyer's reservation price exceeds the seller's:

$$P_{it} = \begin{cases} \text{observed,} & \text{if } RP_{it}^b - RP_{it}^s \geq 0 \\ \text{unobserved,} & \text{if } RP_{it}^b - RP_{it}^s < 0. \end{cases} \quad (3)$$

The exact price depends on the outcome of a negotiation. The assumption is that the transaction price equals the midpoint between the buyer's and seller's reservation prices.

Thus, the expected transaction price is:

$$E[P_{it}] = \frac{1}{2} \sum_j (\alpha_j^b + \alpha_j^s) X_{ijt}^P + \frac{1}{2} \sum_t (\beta_t^b + \beta_t^s) Z_t + \frac{1}{2} E[(\varepsilon_{it}^b + \varepsilon_{it}^s) | RP_{it}^b \geq RP_{it}^s]. \quad (4)$$

The expected sale price consists of three components: the midpoint between the asset-specific buyer's and seller's perceptions of value, the midpoint between the market-wide buyer and seller perceptions of value, and the expected value of the random error, which is itself the midpoint between the buyer's and seller's random components *among the parties that consummate transactions*. This last term is, in general, nonzero, because of the condition that the buyer's reservation price must exceed the seller's reservation price in any observable transaction.

We can estimate (4) via the following regression:

$$P_{it} = \sum_j a_j X_{ijt}^P + \sum_t \beta_t Z_t + (\varepsilon_{it} | RP_{it}^b \geq RP_{it}^s) \quad (5)$$

where:  $a_j = \frac{1}{2}(\alpha_j^b + \alpha_j^s)$ ,  $\beta_t = \frac{1}{2}(\beta_t^b + \beta_t^s)$ , and  $\varepsilon_{it} = \frac{1}{2}(\varepsilon_{it}^b + \varepsilon_{it}^s)$  and construct a price index using the  $\beta_t$  coefficients.

The stochastic error term in (4) may have a nonzero mean because the observed transaction sample is not a random sample of the buyer and seller populations. It is well known that nonrandomness of the sample will cause simple OLS estimation of (5) to have biased coefficients. This sample selection bias problem can be corrected by a procedure developed by Heckman (1976, 1979). The solution to this problem not only corrects for selection bias, but also allows for complete identification of the parameters of the search model.

The estimation of (5) proceeds in two steps. First, we estimate a probit model of the decision whether to sell the asset or not. The latent variable describing the decision for the  $i$ -th asset in period  $t$  is  $S_{it}^*$ :

$$S_{it}^* = RP_{it}^b - RP_{it}^s. \quad (6)$$

$S_{it}^*$  is not observable, only the outcome  $S_{it}$  is observed:

$$S_{it} = \begin{cases} 1, & \text{if } S_{it}^* \geq 0 \\ 0, & \text{otherwise.} \end{cases} \quad (7)$$

Equation (6) defines  $S_{it}^*$  to equal the difference between the buyer's and seller's reservation prices for the asset. Subtracting (2) from (1) as in (6) yields:

$$S_{it}^* = \sum (\alpha_j^b - \alpha_j^s) X_{ijt}^P + \sum (\beta_t^b - \beta_t^s) Z_t + (\varepsilon_{it}^b - \varepsilon_{it}^s). \quad (8)$$

Equations (7) and (8) are estimated as a probit model:

$$\Pr[S_{it} = 1] = \Phi \left[ \sum \omega_j X_{ijt}^P + \sum \gamma_t Z_t \right] \quad (9)$$

where  $\Phi[ \ ]$  is the cumulative density function (cdf) of the normal probability distribution evaluated at the value inside the brackets, based on  $X_{ijt}^P$  and  $Z_t$ . The probit model estimates the coefficients and residuals only up to a scale factor. The estimated coefficient of  $Z_t$  in (9) is  $\gamma_t / \sigma$  and the estimated error is  $\eta_{it} / \sigma$ , where  $\sigma^2 = \text{Var}(\varepsilon_{it}^b - \varepsilon_{it}^s)$ . Label the estimated probit coefficient  $\hat{\gamma}_t$ , so that:  $\hat{\gamma}_t = \gamma_t / \hat{\sigma} = (\hat{\beta}_t^b - \hat{\beta}_t^s) / \hat{\sigma}$ . From the estimation results of the probit, we construct the inverse Mills ratio ( $\lambda_{it}$ ). The inverse Mills ratio equals the ratio of the pdf to the cdf evaluated at time t for observation i (Maddala, 1985, p. 224).

The second step in the procedure is to estimate an OLS hedonic price equation including as explanatory variables those listed in equation (5), and  $\lambda_{it}$ .

$$P_{it} = \sum a_j X_{ijt}^P + \sum \beta_t Z_t + \sigma \varepsilon \eta \lambda_{it} + v_{it}. \quad (10)$$

where  $\sigma_{\varepsilon\eta}$  equals the covariance of the errors in (5) and (9). As noted by Greene (2000),  $v_{it}$  has zero mean and the above estimation produces consistent estimates of the coefficients, but heteroscedasticity is present because  $\lambda_{it}$  is an estimated value.

Equation (10) provides a model of observed equilibrium transaction prices in the asset market. Equation (9) provides a model of observed equilibrium transaction volume as reflected in the sale probability of a given asset. Each of these equations reflects the movements in the demand and supply sides of the asset market, but in different ways. As shown in FGGH, this enables us to identify and estimate movements in the buyers and sellers price distributions.

### **III. The Data**

The data used for this study were obtained from the Florida Department of Revenue (DOR). They are compiled annually by the DOR under a statutory provision requiring the auditing of each of the 67 counties' property tax master files. The data are provided annually as a cross-sectional database and include the most recent sale prices and sale dates, the property type, size, year built, homestead designation and a limited number of other property- and owner-specific characteristics for every parcel in the state of Florida.

Following Beal and Gatzlaff (2005), property records were initially selected for single-family detached residences (land use code 01) having a total living area (*TLA*) of greater than 500 and less than 7,000 square feet and located within a county of the 20 Metropolitan Statistical Areas (MSAs) in Florida.<sup>1</sup> Data files were available for each county from the DOR for each tax year from 1995 through 2009. Transaction information of existing homes for the years 1994 to 2008 were listed on these data files as the most recent sale and allowed *SOLD* and *UNSOLD* properties to be identified for each year. To ensure the panel spanned a complete business

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<sup>1</sup> Florida MSAs include Bradenton-Sarasota, Cape Coral-Ft. Myers, Daytona Beach, Ft. Walton Beach, Gainesville, Jacksonville, Lakeland, Miami-Ft. Lauderdale, Naples, Ocala, Orlando, Palm Bay-Melbourne, Palm Coast, Panama



“cycle,” the data series was extended to include the previous six years through 1988. For these years, *SOLD* and *UNSOLD* data were identified using the 1995 tax roll data by sequentially omitting records for those properties constructed after the year of interest, respectively, and by merging the most recent and second most recent sale information. This resulted in a panel of data that includes of both *SOLD* and *UNSOLD* single-family homes in all Florida MSA counties for each year from 1988 to 2008.

A series of steps, consistent with Gatzlaff and Ling (1994), were conducted to delete incomplete and incompatible observations or apparent data errors. Because transaction and price dynamics are likely different for attached housing, only single-family detached units (homestead and non-homesteaded properties) were selected. To ensure the sale observations represent arm’s length transactions made under typical conditions the *SOLD* data were restricted to qualified sales (as identified by local property appraisers). After filtering the data, the complete data set consisted of approximately 35.4 million observations. With the exception of annual variations, the general sales frequency trend was strongly positively correlated with the annual movements in single family home prices. This relationship is graphed in Figure 2.

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Insert Figure 2 about here  
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Sampling was employed to manage and test the large dataset. The sold and unsold observations were sampled separately. Homes that sold were randomly sampled at a rate of 25.0% to ensure a sufficient number of reliable *SOLD* observations for the analyses and 2.0% of the *UNSOLD* observations.<sup>2</sup> The final data set used for analysis consisted of approximately 2.16 million observations, of which 1.12 million (52.1%) are sales and 1.03 (47.9%) are non-sales. Summary statistics of the *SOLD* and *UNSOLD* samples are reported in Table 1.

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City, Pensacola, Port St. Lucie, Punta Gorda, Tallahassee, Tampa-St. Petersburg, and Sebastian-Vero Beach. The U.S. Census Bureau estimates that the MSAs represented 94.1 percent of Florida’s population in 2009.

<sup>2</sup> Test statistics in the following sections are subsequently weighted to reflect the population’s *SOLD* and *UNSOLD* properties.

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Insert Table 1 about here  
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#### IV. Empirical Results

To estimate the selection-corrected and constant-liquidity indices, we estimate equations (9) and (10) using the sampled data for the entire state (FL\_all). The dependent variable (*SOLD*) is a dummy variable equal to 1 if the property sold in period *t*; otherwise it is 0. The probit equation includes independent variable denoting the property's size (*SQFTG*); its effective year built (*YRBLT*); and time dummies (the omitted year dummy was 1988). The results were consistent with expectations. The likelihood of sale was positively (significantly) correlated with both the property's size and year built. The results from the first stage of the Heckman-selection weighted probit model are reported in Table 2.

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Insert Table 2 and 3 about here  
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Results of the second stage of the selection-corrected Heckman estimate of (10) are reported in Table 3. The dependent variable (*lnP*) is log of the sale price in period *t*. Independent variables include the property's size (*SQFTG*), its effective year built (*YRBLT*), land size (*LAND*), county dummies, year dummies, and the inverse mills ratio (correcting for select characteristics). Property size, year built, and land size are all significantly correlated with sale price and the year dummies appear to follow a reasonable trend. It is noted that selection correction variable,  $\lambda$ , is statistically significant.

Following the procedures outlined by FGGH (2003) we construct constant-liquidity indices using the statewide data set. Four alternative indices are reported in Table 4. Columns 2, 3, 4 and 5 of Table 4 indicate standard hedonic, selection-corrected, constant-liquidity demand and constant-liquidity supply indices, respectively. Although the selection correction variable,  $\lambda$ , was significant, little deviation is noted between the standard hedonic and the selection corrected indices. Thus, the quantifiable effect of the selectivity on the large sample estimate is

limited. We are particularly interested in noting deviations between the selection corrected and the constant-liquidity indices. These are outlined in Columns 6, 7, and 8, which indicate annual changes in the selection-corrected (Heckman) and the constant-liquidity measures (Demand and Supply). Meaningful annual deviations are noted. The average annual change of the selection-corrected value index (3.2%) is slightly greater than the average annual change of the demand index (2.4%) and less than that of the supply index (4.0%), while the volatilities as greatest in the demand index (9.9%) when compared to the value (8.3%) and supply indices (8.0%). Figures 3 and 4 graph the alternative index levels and their annual changes. It is important to note that the relative movements of the demand and supply indices appear to be related to subsequent moves in the value index (i.e., increases in demand relative to supply, and vice versa, are followed by price increases in the value index).

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Insert Table 4, Figures 3.1, and 3.2 about here  
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To evaluate whether these similar results are found within Florida's local markets, standard hedonic, selection-corrected hedonic and constant-liquidity indices were estimated for those areas where sufficient sales data were available. Consistent with the statewide indices, we find that there is evidence of a selective nature at the MSA-level price indices (i.e., statistically significant lambdas), but again the corrected index adjustments are not large and the resulting indices do not typically differ substantially from standard hedonic price measures. In contrast, MSA-level constant-liquidity (i.e., buyer-demand) indices do often differ from the standard selection-corrected measures and their movements generally appear to lead the selection-corrected and standard hedonic measures. Figures 4.1, 5.1, and 6.1 compare the index levels for three of the areas estimated (the Miami-Ft. Lauderdale (MSA) in Southeast Florida; the coastal areas of St. Petersburg and Bradenton in West Central Florida; and the Pensacola (MSA) in Northwest Florida). The areas were selected for their varied size, location, and demographic mix. Although the index levels and movement vary, the patterns presented between the selection-

corrected and constant-liquidity are generally consistent. The constant-liquidity measure tends to move back and forth across the corrected hedonic and, consistent with the model expectations, appears to lead the standard measure in most cases.

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Insert Figures 4.1, 4.2, 5.1, 5.2, 6.1, and 6.2 about here  
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To look at further at the nature of these deviations and whether they are related to economic cycles we define the deviations, *DIFF*, as the annual change in constant-liquidity indices, demand less supply. The correlation of *DIFF* with a very limited, but often cited, set of economic factors affecting housing market cycles is explored. These factors include, the local unemployment rate (*UER*); the nominal level of mortgage interest rates (*MRATE*); the change in the local unemployment rate (*dUER*); the change in the nominal annual mortgage rate (*dMRATE*). The correlation of these variables with *DIFF* is evaluated using OLS regression. To evaluate the collinearity, and its effect among the dependent variables on the regression coefficient, estimates a simple correlation matrix of is provided in Table 5. Moderate to strong negative correlations are reported between *DIFF* and contemporaneous measures of *UER*, *MRATE*, and *dUER*. In addition, moves in *UER*, *MRATE* and *dUER* are moderately correlated (positively), while *dMRATE* is negatively correlated with unemployment and positively correlated with *MRATE*.

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Insert Tables 5 and 6 about here  
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The results of the OLS regressions are reported in Table 6. Two panels of regressions are reported. The first panel reports the results from regressing *UER*, *MRATE*, *dUER*, and *dMRATE* on *DIFF* at time *t*, and the second reports the results from regressing the same variables on the subsequent year's *DIFF* (*t+1*). Panel A suggests that contemporaneous increases (decreases) unemployment rates decrease (increase) the spread in the demand-supply indices; however, contemporaneous changes in the mortgage rate does not change the relative movement in the indices. Recall, that this looks at the relative moves in the buyer and seller reservation prices, not

the actual asset prices. Panel B indicates that the unemployment rate and changes in the unemployment rate in the *previous* period are strongly correlated (negatively) with the spread in the demand-supply indices, and again, moves in the mortgage rates appear to affect both buyers and seller reservation prices similarly. Thus, preliminary evidence indicates that the deviations between movements in the constant-liquidity indices and the selection-corrected indices are negatively correlated with movements in general economic conditions (as represented by unemployment rates). This is consistent with the idea that buyers' reservation prices respond more (or quicker) than sellers' to new relevant price information and with the notion that seller reservation prices are "sticky" and respond more slowly than buyer reservation prices.

To consider the relationship of the demand-supply indices on prices, *DIFF* is regressed on the annual changes in the selection-corrected price index ( $dlnP$ ) and the results are reported in Table 7. Both contemporaneous and lagged changes in *DIFF* are strongly (positively) correlated with changes in price. However, relative changes in demand-supply (*DIFF*) over the previous period appear to dominate the effect of contemporaneous changes. This is consistent with the idea that the pricing mechanism in the housing market is not immediate (less than efficient) and results in price moves that are serially correlated. Including previous price information ( $dlnP(t-1)$ ) in the regression model (7.5) does not eliminate the effect of demand-supply changes on subsequent price changes.

## **V. Conclusion**

We extend previous work by FGGH, 2003, to (1) explore the feasibility of estimating selected-corrected and constant-liquidity indices for the housing market; and (2) to compare and contrast the results of the alternative indices. We note that while there is evidence of selectivity in using statewide and MSA-level sales data to estimate standard hedonic price indices, the selection-corrected index adjustments are not large. Both statewide and MSA-level constant-liquidity (i.e., buyer-demand, seller-supply) indices are found to differ from standard and

selection corrected measures. In addition, their movements generally appear to lead the selection-corrected and standard hedonic measures.

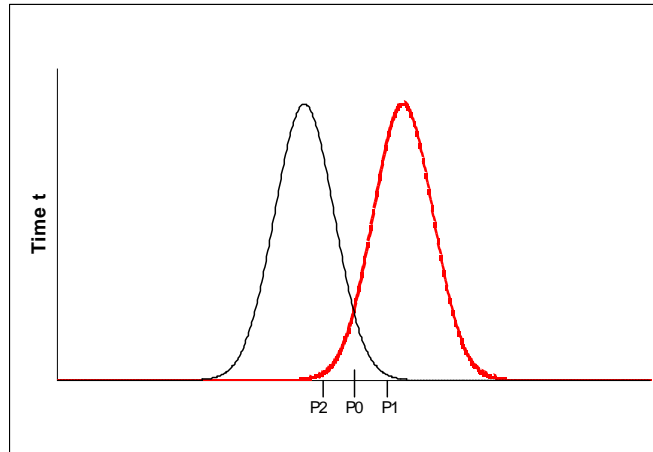
Preliminary evidence indicates that the deviations between movements in the constant-liquidity demand and supply indices are correlated with general economic factors. Deviations are found to be strongly (negatively) correlated with changes in unemployment mortgage rate, consistent with the idea that buyers' reservation prices respond quicker (or greater) than sellers' to new relevant price information. However, reservation prices of buyers' and sellers' appear to respond similarly to changes in mortgage rates. Finally, movements in the reservations prices of buyers' and sellers' over both the current and previous periods appear to effect on price changes, consistent with the idea that the privately negotiated pricing mechanism in the housing market is less information efficient than that of publicly-traded assets (i.e., stocks and bonds).

## **VI. References**

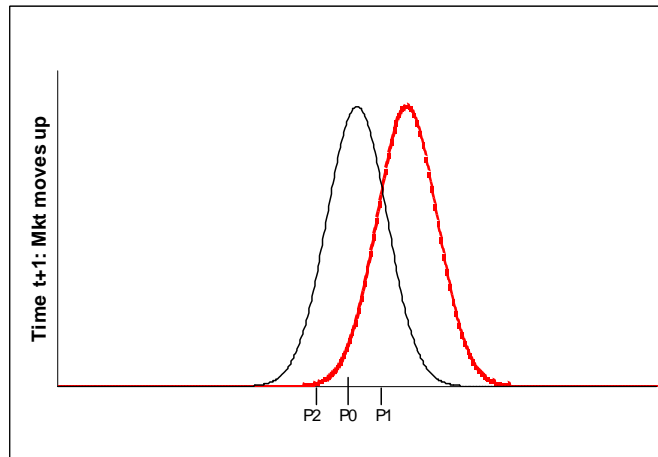
- Fisher, J., D. Geltner, D. Gatzlaff and D. Haurin. 2004. An Analysis of the Determinants of Transaction Frequency of Institutional Commercial Real Estate Investment Property. *Real Estate Economics*, Vol. 32(2), 239-264.
- Fisher, J., D. Geltner, D. Gatzlaff and D.Haurin. 2003. Controlling for the Impact of Variable Liquidity on Commercial Real Estate Price Indices. *Real Estate Economics*, Vol. 31(2), 269-303.
- Fisher, J., D. Geltner, and B. Webb, 1994. "Value Indices of Commercial Real Estate: A Comparison of Index Construction Methods" *Journal of Real Estate Finance and Economics* 9: 137-164.
- Gatzlaff, D., and D. Geltner, 1998. "A Transaction-Based Index of Commercial Property and its Comparison to the NCREIF Index" *Real Estate Finance* 15: 7-22.
- Gatzlaff, D., and D. Haurin, 1997. "Sample Selection Bias and Repeat Sale Index Estimates" *Journal of Real Estate Finance and Economics* 14: 33-50.
- Gatzlaff, D., and D. Haurin, 1998. "Sample Selection and Biases in Local House Value Indices" *Journal of Urban Economics* 43: 199-222.
- Goetzmann, W., 1993. "Accounting for Taste: Art and the Financial Markets Over Three Centuries" *American Economic Review* 83(5): 1370-1377.
- Gompers, P. and J. Lerner, 2000. "Money Chasing Deals? The Impact of Fund Inflows on Private Equity Valuations" *Journal of Financial Economics* 55: 281-325.

- Greene, W., *Economic Analysis*, 4th Ed., 2000. Prentice Hall, Upper Saddle River, NJ.
- Haurin, D. and L. Gill. 2002. The Impact of Transaction Costs and the Expected Length of Stay on Homeownership. *Journal of Urban Economics*, Vol. 51, 563-584.
- Heckman, J., 1976. "The Common Structure of Statistical Models of Truncation, Sample Selection and Limited Dependent Variables and a Simple Estimator for such Models" *Annals of Economic and Social Measurement* 5: 475-492.
- Heckman, J., 1979. "Sample Selection Bias as a Specification Error" *Econometrica* 47: 153-161.
- Lippman, S. & J. McCall, 1976. "The Economics of Job Search: A Survey" *Economic Inquiry* 14: 155-189.
- Maddala, G. S., 1985. "Limited-Dependent and Qualitative Variables in Econometrics," *Econometric Society Monographs*, Cambridge University Press, New York, NY.
- Munneke, H. and B. Slade, 2000. "An Empirical Study of Sample Selection Bias in Indices of Commercial Real Estate" *Journal of Real Estate Finance & Economics* 21(1): 45-64.
- Peng, L., 2001. "Building a Venture Capital Index" Unpublished Working Paper. Yale University.
- Rosen, S., 1974. "Hedonic Prices and Implicit Markets" *Journal of Political Economy* 82:33-55, 1974.
- Wheaton, W., 1990. "Vacancy, Search, and Prices in a Housing Market Matching Model" *Journal of Political Economy* 98(6): 1270-1292.
- Rady, S. and F. Ortalo-Magne. 2001. *Housing Market Dynamics: On the Contribution of Income Shocks and Credit Constraints*. Discussion paper 2001-09, Department of Economics, University of Munich.

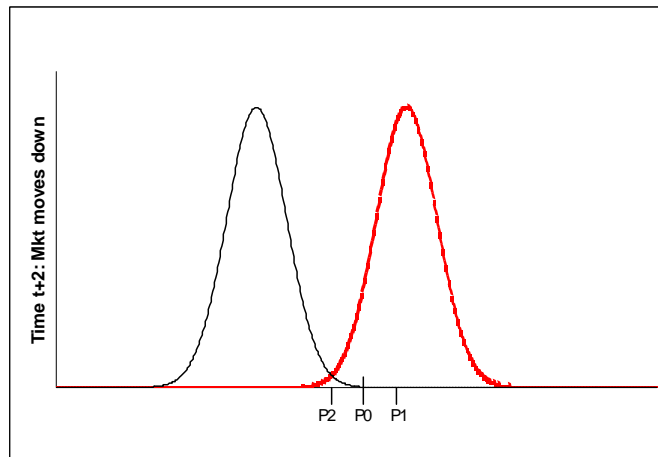
**Figure 1: Buyer/Seller Reservation Prices and Changes in Transaction Freq., FGGH (2003)**



**A. Base Condition (Period t)**



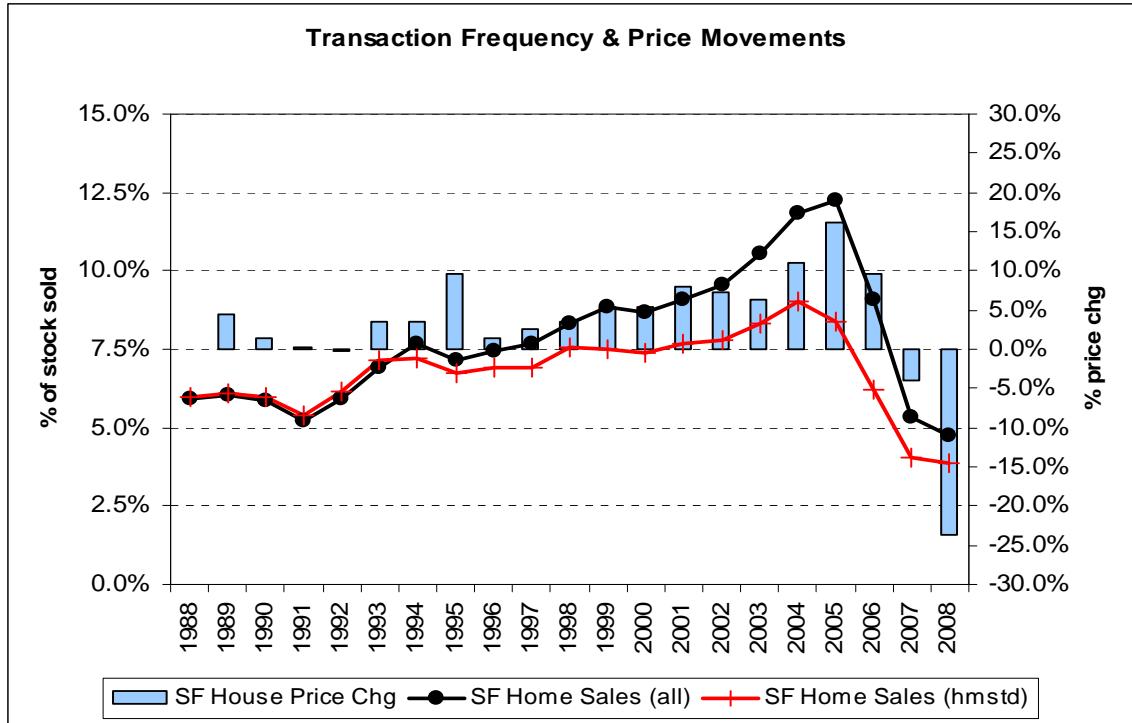
**B. "Up" Market Condition (Period t+1)**



**C. "Down" Market Condition (Period t+2)**



**Figure 2: Florida Housing Units Transacted, Permitted, and Annual Price Changes (1988 to 2008)**



**Table 1: Summary Stats of SOLD and UNSOLD Sample  
(1988 to 2008)**

Year	Panel A: SOLD Obs					Panel B: UNSOLD Obs		
	No. OBS (000s)	Mean PRICE (000s)	No. SOLD (000s)	Mean SQFTG (000s)	Mean YRBLT	No. UNSOLD (000s)	Mean SQFTG (000s)	Mean YRBLT
1988	65.9	88.3	28.9	1.79	1974	37.0	1.67	1966
1989	67.2	94.3	30.1	1.81	1975	37.1	1.68	1966
1990	68.4	96.2	30.1	1.81	1976	38.3	1.69	1967
1991	66.2	97.9	27.1	1.83	1976	39.2	1.70	1968
1992	71.0	99.2	31.5	1.83	1977	39.5	1.71	1968
1993	80.6	105.5	38.6	1.86	1977	42.1	1.72	1969
1994	87.6	110.2	44.6	1.88	1978	43.0	1.74	1970
1995	91.3	116.8	44.8	1.85	1978	46.4	1.73	1971
1996	96.9	122.3	48.6	1.94	1979	48.3	1.79	1971
1997	100.4	129.2	51.1	1.97	1981	49.3	1.80	1972
1998	107.3	135.7	57.1	1.99	1981	50.2	1.82	1973
1999	112.3	144.3	61.6	2.02	1979	50.7	1.86	1973
2000	112.0	157.2	60.8	2.06	1980	51.2	1.87	1974
2001	120.6	169.5	67.0	2.06	1981	53.7	1.89	1974
2002	127.0	184.5	72.3	2.05	1982	54.7	1.91	1975
2003	136.6	203.2	81.5	2.07	1986	55.2	1.93	1976
2004	144.1	235.9	90.3	2.07	1986	53.7	1.95	1977
2005	152.7	286.1	97.2	2.08	1988	55.5	1.98	1979
2006	136.0	312.2	75.6	2.11	1990	60.5	2.00	1980
2007	108.5	307.9	44.8	2.15	1990	63.6	2.01	1981
2008	105.8	248.9	40.8	2.16	1992	65.0	2.01	1984
Totals	2,158.9		1,124.2			1,034.7		

Note: *SOLD* denotes the sampled number of single-family detached housing units sold annually. *UNSOLD* denotes the sampled number of single family detached units available but not sold. *SOLD* observations were over-sampled and represent 52.1 percent of the 1,124.2 thousand observation sample. *SQFTG* and *YRBLT* denote the square footage of total living area and effective year built, respectively.

**Table 2: Results of First Stage Heckman-Selection Probit Model of Sale Probability  
(1988 to 2008, Dep. Var. = SOLD)**

	Coef.	Std.Err.	t	P> t	[95% Conf. Interval]	
sqftg	1.27E-05	9.27E-07	13.72	0	1.09E-05	1.45E-05
yrblt	0.015	5.27E-05	276.71	0	0.014	0.015
yr1989	-0.006	0.0054	-1.05	0.294	-0.016	0.005
yr1990	-0.028	0.0053	-5.25	0	-0.039	-0.018
yr1991	-0.100	0.0054	-18.54	0	-0.110	-0.089
yr1992	-0.044	0.0053	-8.28	0	-0.054	-0.034
yr1993	0.028	0.0052	5.42	0	0.018	0.038
yr1994	0.069	0.0051	13.42	0	0.059	0.079
yr1995	0.023	0.0051	4.46	0	0.013	0.033
yr1996	0.030	0.0050	6.06	0	0.021	0.040
yr1997	0.033	0.0050	6.51	0	0.023	0.042
yr1998	0.067	0.0050	13.57	0	0.058	0.077
yr1999	0.102	0.0050	20.52	0	0.092	0.112
yr2000	0.080	0.0050	16.17	0	0.071	0.090
yr2001	0.097	0.0049	19.68	0	0.087	0.106
yr2002	0.117	0.0049	23.87	0	0.107	0.126
yr2003	0.143	0.0049	29.38	0	0.133	0.152
yr2004	0.193	0.0049	39.49	0	0.183	0.202
yr2005	0.193	0.0048	39.72	0	0.183	0.202
yr2006	-0.004	0.0048	-0.92	0.356	-0.014	0.005
yr2007	-0.295	0.0049	-59.88	0	-0.305	-0.286
yr2008	-0.389	0.0050	-78.49	0	-0.398	-0.379
_cons	-30.306	0.1034	-293.16	0	-30.508	-30.103

Note: *SQFTG* denotes the square footage of the living area; *YRBLT* is the effective year built.

**Table 3: Results of Second Stage Selection-Corrected Hedonic Price Model (1988 to 2008, Dependent Var. = ln P)**

Heckman selection model (regression model with sample selection)	Number of obs = 2,158,956 Censored obs = 1,034,709 Uncensored obs = 1124247 Wald chi2(23) = 2.20e+06 Prob > chi2 = 0.0000
Log pseudolikelihood = -1.63e+07	

	Coef.	Std.Err.	t	P> t	[95% Conf. Interval]	
sqftg	0.0004	1.23E-06	300.10	0	0.000	0.000
yrblt	0.004	3.86E-05	100.77	0	0.004	0.004
land	2.73E-06	3.59E-08	76.16	0	2.66E-06	2.8E-06
yr1989	0.044	0.004	11.83	0	0.037	0.051
yr1990	0.058	0.004	15.30	0	0.050	0.065
yr1991	0.058	0.004	14.73	0	0.050	0.066
yr1992	0.059	0.004	15.01	0	0.051	0.066
yr1993	0.093	0.004	24.77	0	0.086	0.101
yr1994	0.128	0.004	35.13	0	0.121	0.135
yr1995	0.219	0.003	67.31	0	0.212	0.225
yr1996	0.234	0.003	76.73	0	0.228	0.240
yr1997	0.260	0.003	85.82	0	0.254	0.266
yr1998	0.295	0.003	98.54	0	0.289	0.301
yr1999	0.347	0.003	115.41	0	0.341	0.353
yr2000	0.400	0.003	132.88	0	0.394	0.406
yr2001	0.477	0.003	159.39	0	0.471	0.483
yr2002	0.548	0.003	182.00	0	0.542	0.554
yr2003	0.610	0.003	201.22	0	0.604	0.616
yr2004	0.716	0.003	225.73	0	0.710	0.722
yr2005	0.866	0.003	250.62	0	0.860	0.873
yr2006	0.956	0.004	272.98	0	0.949	0.963
yr2007	0.911	0.003	260.48	0	0.905	0.918
yr2008	0.641	0.004	164.54	0	0.633	0.648
_cons	2.767	0.076	36.65	0	2.619	2.915
/athrho	0.027	0.001	37.44			
/lnsigma	-0.981	0.002	-456.27			
rho	0.027	0.001	37.46	0		
sigma	0.375	0.001	465.13	0		
lambda	0.010	0.000	38.99	0		

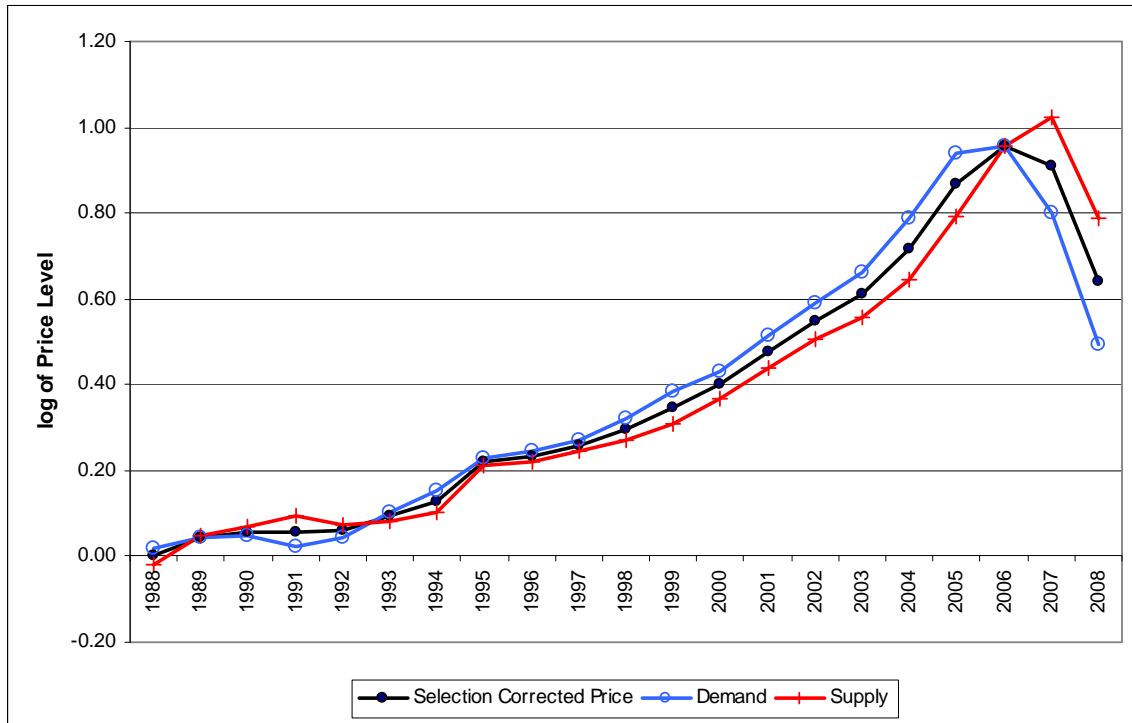
Wald test of indep. eqns. (rho = 0): chi2(1) = 1401.63 Prob > chi2 = 0.0000

Note: County dummies, C<sub>j</sub>, are included in the above estimate but are not reported in the above results.

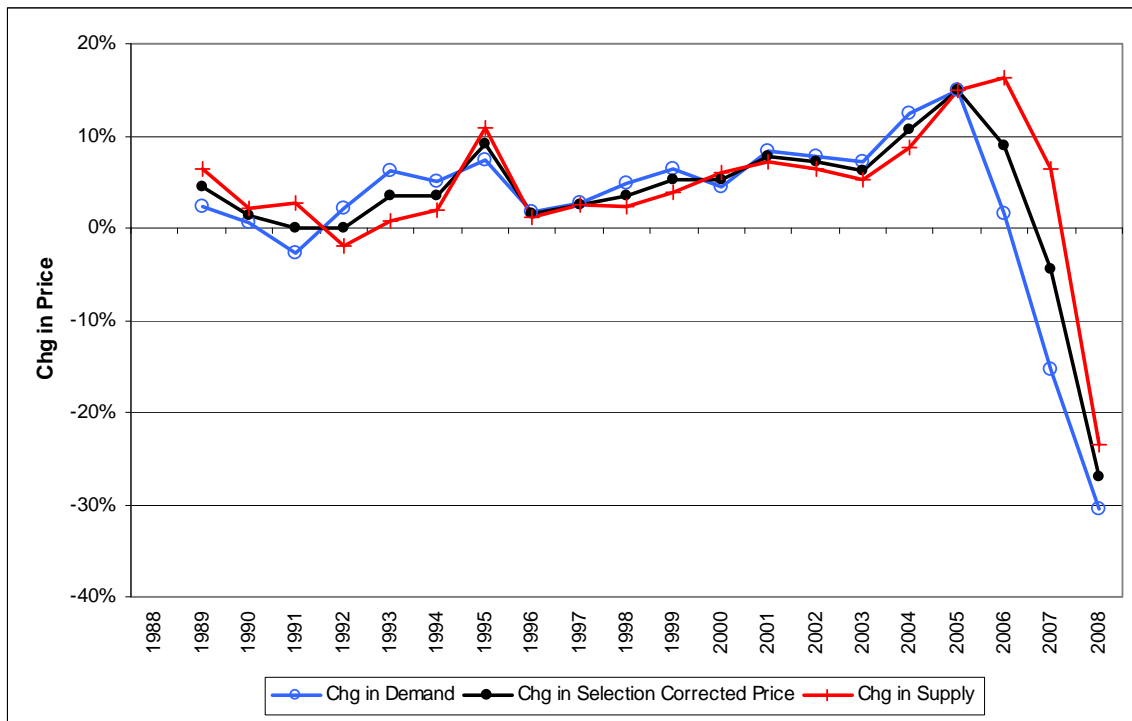
**Table 4: Estimates of House Value, Demand and Supply Index Movements  
(1986 to 2004)**

Year	Standard Hedonic	Selection Corrected	Demand	Supply	Chg in Heckman	Chg in Demand	Chg in Supply
1988	0.000	0.000	0.019	-0.019	n.a.	n.a.	n.a.
1989	0.044	0.044	0.042	0.046	0.044	0.023	0.065
1990	0.058	0.058	0.047	0.068	0.014	0.005	0.022
1991	0.059	0.058	0.021	0.096	0.000	-0.026	0.027
1992	0.059	0.059	0.042	0.075	0.001	0.021	-0.020
1993	0.093	0.093	0.104	0.083	0.035	0.062	0.008
1994	0.127	0.128	0.154	0.102	0.034	0.050	0.019
1995	0.218	0.219	0.227	0.210	0.091	0.074	0.108
1996	0.233	0.234	0.245	0.222	0.015	0.018	0.012
1997	0.259	0.260	0.272	0.248	0.026	0.027	0.025
1998	0.294	0.295	0.320	0.270	0.035	0.048	0.022
1999	0.346	0.347	0.385	0.309	0.052	0.065	0.039
2000	0.399	0.400	0.430	0.370	0.053	0.045	0.061
2001	0.476	0.477	0.513	0.441	0.077	0.084	0.071
2002	0.546	0.548	0.592	0.504	0.071	0.079	0.064
2003	0.607	0.610	0.663	0.556	0.062	0.071	0.052
2004	0.713	0.716	0.788	0.644	0.106	0.125	0.088
2005	0.862	0.866	0.938	0.794	0.150	0.150	0.150
2006	0.953	0.956	0.954	0.957	0.089	0.016	0.163
2007	0.912	0.911	0.801	1.022	-0.044	-0.153	0.065
2008	0.642	0.641	0.495	0.787	-0.271	-0.306	-0.236
				Mean =	0.032	0.024	0.040
				Std.Dev. =	0.083	0.099	0.080

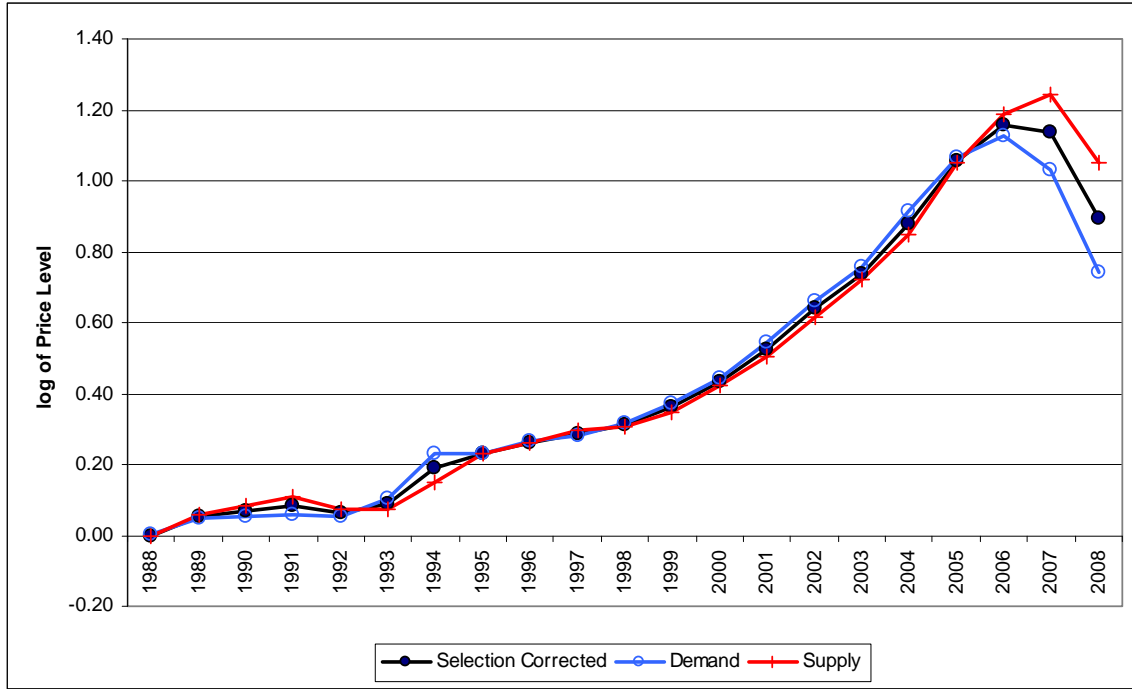
**Figure 3.1: Log of Florida House Value, Demand, and Supply Indices (1988 to 2008)**



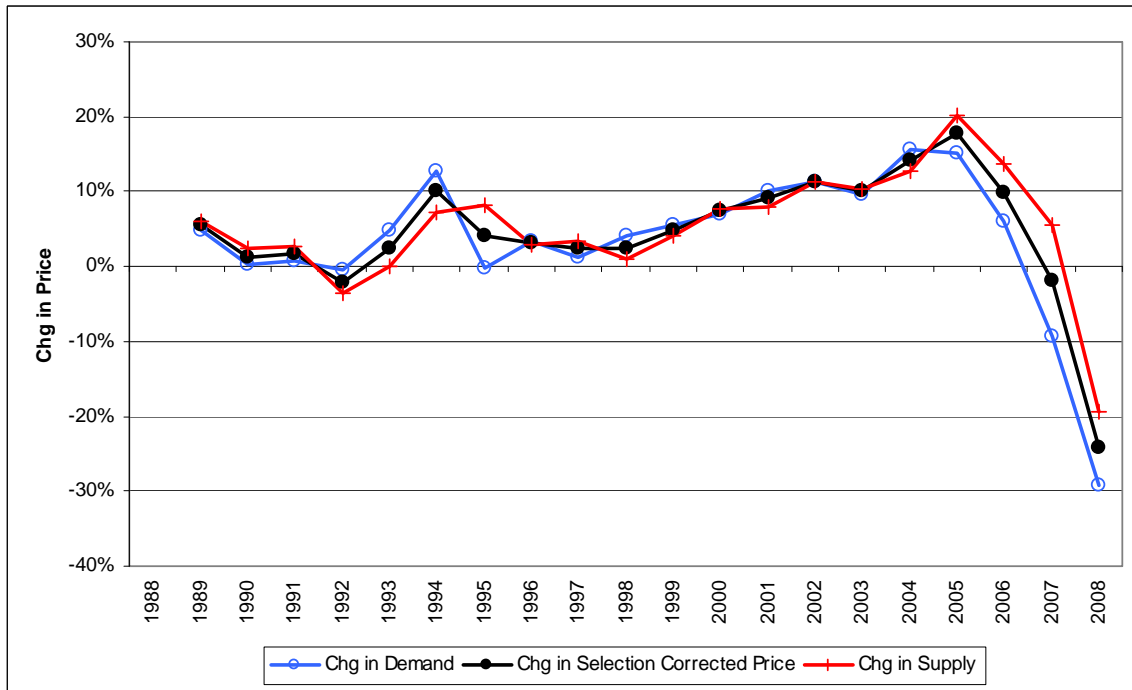
**Figure 3.2: Annual Changes in Florida House Value, Demand, and Supply Indices (1988 to 2008)**



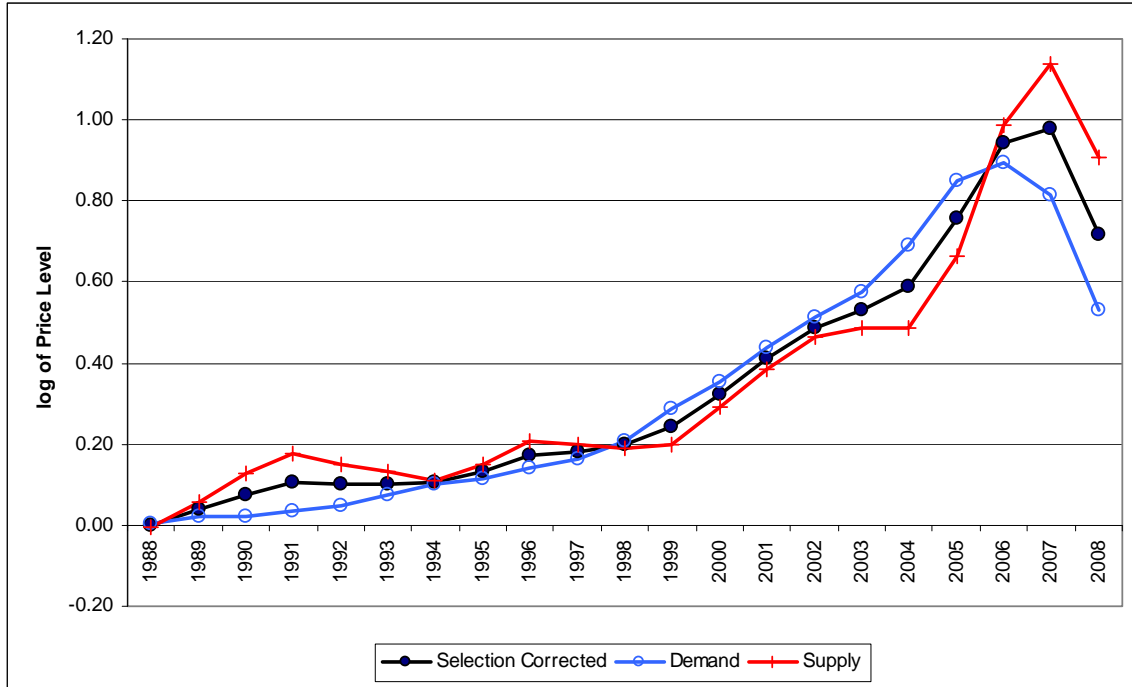
**Figure 4.1: Log of House Value, Demand, and Supply Indices (Southeast FL --Miami-Ft. Lauderdale-- 1988 to 2008)**



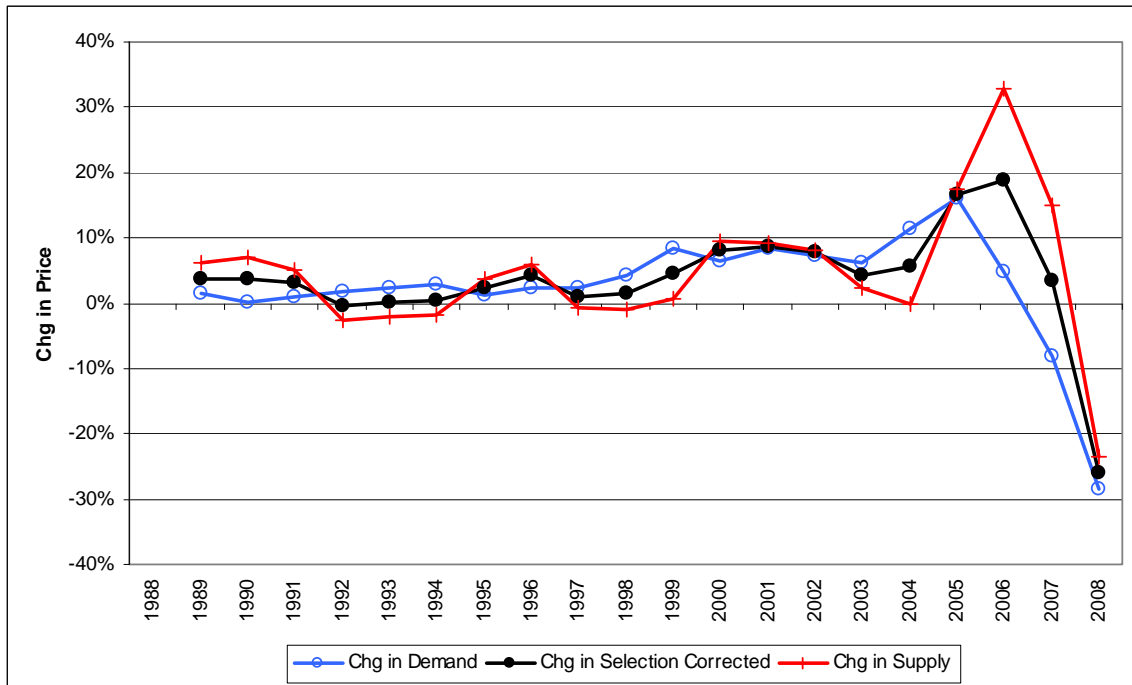
**Figure 4.2: Annual Changes in House Value, Demand, and Supply Indices (Southeast FL --Miami-Ft. Lauderdale-- 1988 to 2008)**



**Figure 5.1: Log of House Value, Demand, and Supply Indices  
(West Central, FL --St. Petersburg & Bradenton-- 1988 to 2008)**

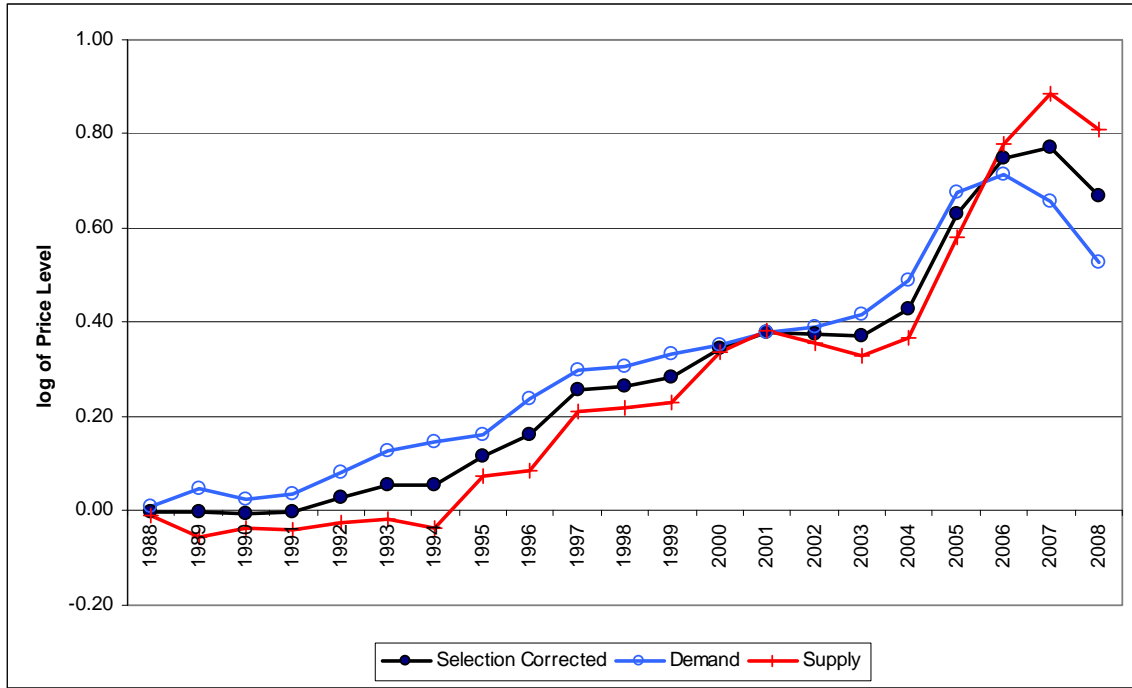


**Figure 5.2: Annual Changes in House Value, Demand, and Supply Indices  
(West Central, FL --St. Petersburg & Bradenton-- 1988 to 2008)**

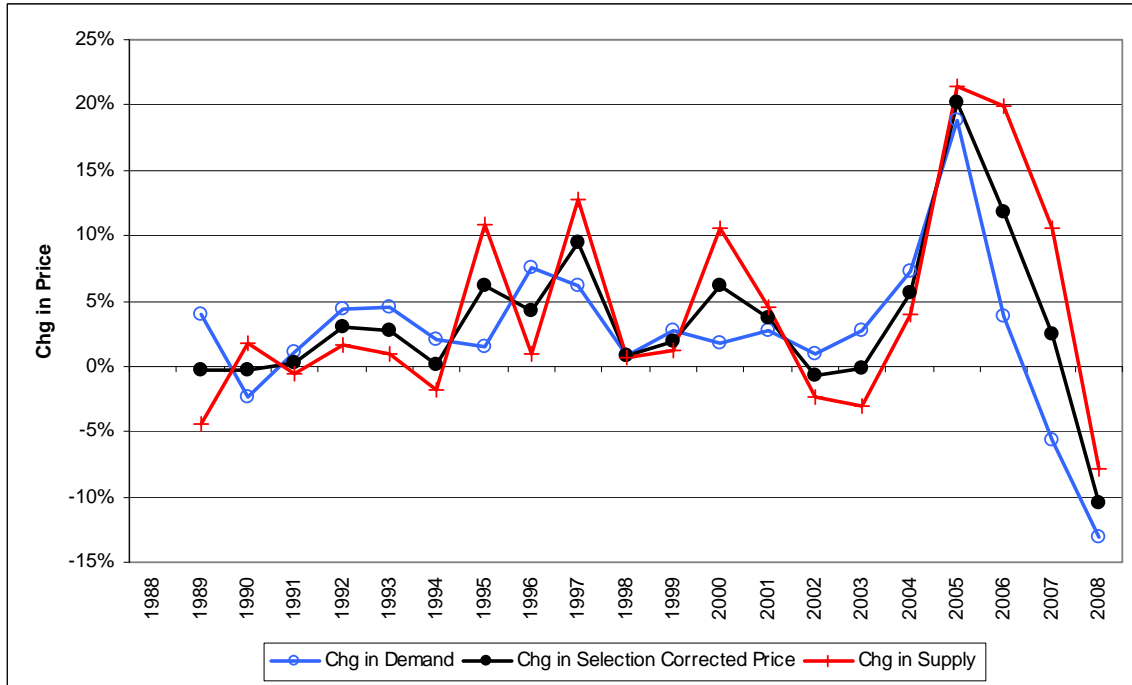




**Figure 6.1: Log of House Value, Demand, and Supply Indices  
(Northwest, FL --Pensacola-- 1988 to 2008)**



**Figure 6.2: Annual Changes in House Value, Demand, and Supply Indices  
(Northwest, FL --Pensacola-- 1988 to 2008)**



**Table 5: Correlation Matrix for Select Economic Variables**

	<i>DIFF</i>	<i>UER</i>	<i>MRATE</i>	<i>dUER</i>	<i>dMRATE</i>
<i>DIFF</i>	1.00				
<i>UER</i>	-0.22	1.00			
<i>MRATE</i>	-0.14	0.39	1.00		
<i>dUER</i>	-0.61	0.34	0.17	1.00	
<i>dMRATE</i>	0.03	-0.41	0.15	-0.23	1.00

**Table 6: OLS Regression of MSA Differences on Select Economic Variables (1988 – 2008, Dep. Var. = *DIFF*)**

	Dep. Var. = <i>DIFF</i> (t)		Dep. Var. = <i>DIFF</i> (t+1)	
	6.1 coef. est (t-stat)	6.2 coef. est (t-stat)	6.3 coef. est (t-stat)	6.4 coef. est (t-stat)
<i>UER</i>	-1.43 (-0.77)	-0.52 (-0.28)	-3.24 (-2.61)	-2.78 (-2.01)
<i>MRATE</i>	-0.47 (-0.27)	0.10 (0.06)	-0.10 (-0.08)	0.32 (0.24)
<i>dUER</i>		-7.05 (-3.01)		-3.64 (-2.18)
<i>dMRATE</i>		-1.99 (-0.64)		-0.77 (-0.34)
Constant	0.13 (0.93)	0.03 (0.26)		0.16 (0.96)
R2	0.05	0.39	0.34	0.50
Adj-R2	-0.05	0.24	0.26	0.37
F-stat	0.48	2.61	4.41	3.74
F-signif	0.63	0.07	0.03	0.03

Note: The dependent variable, *DIFF*, is annual difference between the constant-liquidity buyers' demand and sellers' supply indices. *UER* denotes the county-specific June unemployment rate each year as reported by the Bureau of Labor Statistics; *dUER* denotes the annual change in *UER*; *MRATE* is the nominal mortgage rate on a conventional fixed-rate mortgage as of June 30 reported by the Federal Reserve; *dMRATE* is the annual change in *MRATE*.

**Table 7: OLS Regression of Prices on Demand-Supply Movements  
(1988 – 2008, Dep. Var. =  $\ln P$ )**

	7.1	7.2	7.3	7.4	7.5
	coef. est	coef. est	coef. est	coef. est	coef. est
	(t-stat)	(t-stat)	(t-stat)	(t-stat)	(t-stat)
<i>DIFF</i> (t)	0.68		0.32		0.23
	(7.88)		(3.34)		(1.82)
<i>DIFF</i> (t-1)		0.94	0.60		0.85
		(9.58)	(4.72)		(3.36)
$\ln P$ (t-1)				1.09	-0.34
				(3.04)	(-1.13)
Constant	0.02	0.01	0.12	-0.02	0.02
	(2.56)	(0.85)	(1.82)	(-0.78)	(2.00)
R <sup>2</sup>	0.77	0.84	0.90	0.34	0.91
Adj-R <sup>2</sup>	0.75	0.83	0.89	0.30	0.89
F-stat	62.11	91.71	77.38	9.22	52.82
F-signif	0.00	0.00	0.00	0.01	0.00

Note: The dependent variable,  $\ln P$ , is the annual change in the selection-corrected price index. *DIFF*, is difference between the constant-liquidity demand and supply indices. *UER* is the county-specific June unemployment rate each year as reported by the Bureau of Labor Statistics; *dUER* denotes the annual change in *UER*; *MRATE* is the nominal mortgage rate on a conventional fixed-rate mortgage as of June 30 reported by the Federal Reserve; *dMRATE* is the annual change in *MRATE*.