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The Impact of Interest Rates and Employment on Nominal Housing Prices

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This research examines how well nominal income, nominal interest rates and employment explain temporal variation in nominal metropolitan area house prices. Rather than use a traditional model of real house prices, we explain nominal house prices with a measure of "intrinsic" house value that combines local economic factors with an affordable price based upon what the local median income household could afford to pay at prevailing interest rates. The affordable price variable captures local household income trends and current interest rates. We then relate temporal variation in observed house prices to "intrinsic" value and estimate the parameters of separate autoregressive house price models for 316 cities. We observe that the coastal markets exhibit much greater appreciation/ depreciation rates and much more volatility than cities in the central portions of the country. Here we focus primarily on the impact of interest rates on nominal prices in various MSAs, a factor that many housing analyst have pointed to when debating the existence of housing bubbles. Some markets are much more or less responsive to interest rates than others. Supply constraints may explain some of this increased responsiveness.

Keywords

housing prices; negative equity; interest rate impact

Introduction

From 2000 through 2004 the stock market was very perilous with most investors losing substantial wealth. Searching for safe harbor investments and finding interest rates extremely appealing the housing market has seen both increased activity and price increases all across the country. One author touted housing stating “Americans now appear to be treating the purchase of residential real estate as the investment of choice during times of economic uncertainty”.[1]

Understanding the determinants of housing prices is important, not only because housing represents such an important component of wealth, but also because we are now starting to understand the implications of house price trends on mortgage default and collateral risk assessment. With higher loan to value ratios over the past several years and the possibility of some local markets reaching unsustainable prices the default risk from rational default is greater than at any time in the past decade.[2]

Case and Shiller (1989) demonstrated that metropolitan area house prices are serially autocorrelated.[3] High transactions costs, thin markets, and less informed market participants could explain much of what has been observed in housing markets in recent years, that is greater speculation and volatility. Behavioral explanations may be necessary to fully understand home price movements in some markets, but here we focus on fundamental drivers of home prices.

In this paper we explore the responsiveness of home prices at the metropolitan level to changes in interest rates and employment. We estimate separate parameters for a combined fundamental and autoregressive house price model using data for several USA cities. Each market reveals different sensitivities to interest rates and employment changes. Some markets appear to be more cyclical while others appear to be very stable and predictable.

[1] See Trimbath, S. and J. Montoya “A New Kind of Gold? Investment in Housing in Times of Economic Uncertainty” Milken Institute Policy Brief, No. 30, June, 2002, p 1.

[2] Rational default is defined here as negative equity but we are not assuming ruthless default nor are we focusing on the subject of default risk in this paper. We are trying to provide context for the importance of this research.

[3] Karl Case and Robert Shiller have written several papers on predicting home prices, automated valuation and the possible benefits of more efficient housing markets. The firm of Case-Shiller-Weiss has been a market leader and innovator in the area.

Modeling Home Prices: Theory and Literature

Over the long run, and within any particular region, housing prices must result from the forces of demand and supply. Ozanne and Thibodeau (1983) demonstrated that a substantial portion of across metropolitan area variation in house prices could be explained by fundamental economic variables: the size of the market, consumer characteristics (household income, preferences--as measured by socioeconomic/demographic characteristics--and expectations), and housing production variables (operating and capital costs, land prices, and geographic and government growth constraints). The problem with most demographic and some economic variables is that historically they have not been available at the local or regional level with sufficient accuracy in near time to be very effective for modeling future housing demand. Among those economic drivers most likely to be current are interest rates and employment (or unemployment) rates.

In addition to household income (and wealth), mortgage interest rates influence how much housing a household can afford. Information on household income and mortgage interest rates is becoming more available.[4]

Housing markets do not instantaneously adjust to their long-run equilibrium prices after the market undergoes a demand or supply shock. Therefore explaining variation in house price appreciation rates requires additional modeling. Abraham and Hendershott (1993, 1996) model variation in house price appreciation rates as a function of: (1) changes in the underlying economic determinants of long-run equilibrium house prices (e.g. changes in real incomes, real after tax interest rates, real construction costs and employment); and (2) the rate at which the market adjusts to equilibrium. Abraham and Hendershott (1996) examine real house price appreciation rates for 30 MSAs over the 1977-1992 period and report that inland and coastal cities respond similarly to real income growth and user cost variables but have very different responses to disequilibrium. They report that house prices in coastal cities tend to exhibit price bubbles but inland cities do not. This was one of the first comprehensive price trend studies completed and it goes back to a publication date of only 1993 as such has been the difficulty of acquiring sufficient quality data to complete such an exercise.[5]

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[4] Sources such as economy.com now provide MSA level data on a monthly basis.

[5] Robert Edelstein of Berkeley had asked one of the authors in 1985 after a presentation on our leading indicators of the housing market paper using only technical indicators, “why not use fundamental variables like income and employment?” and we replied that we could not yet acquire sufficient data across local markets while our leading indicator variables such as time on the market and selling price over list price where more widely available with less reporting lag. Using fundamental data was always a good idea but until recently quite a challenge.

Quigley (1999) develops a model of house price that is a function of the interaction of several variables including population, income, employment, construction permits, owner occupied vacancy rate, and the lagged price which works fairly well on 41 metropolitan markets. Using the change in price as the dependent variable over a nine-year period with 259 observations the *R*-squared values approach 0.29 when no prior price terms are used and 0.963 when lagged prices are incorporated. Quigley (1999) estimated turning points in the price trends with a fair degree of success. Lagged prices formed credible predictors of turning points.

Malpezzi (1999) and Meen (2002) use error correction models to examine temporal variation in house prices. Malpezzi (1999) examines how housing markets revert to an equilibrium house price to income ratio for 133 metropolitan areas during the 1979 through 1996 period. Malpezzi (1999) reported that house price changes were partly forecastable. Meen (2002) compared national and regional house prices in the U.S. to prices in the U.K. and concluded that differences in observed house price patterns are partly attributable to differences in supply elasticities.

Recently, Capozza, et al. (2004) expanded the exploration of house price dynamics. Using data from 62 metro areas for the 1979-1995 period, they explore patterns of serial correlation in house prices, the notion of mean reversion (towards what we call intrinsic value) as well as how fundamental demand and supply variables (measuring information dissemination, supply costs and expectations) influence house prices. Their empirical results suggest that contemporaneous house prices make up about one-half of the difference between current prices and the long-run equilibrium house price. Capozza, et al. (2004) conclude that serial correlation in house prices is associated with high real construction costs, rapid population growth and high real income growth. They also conclude that metropolitan area size and high income growth are positively related to greater mean reversion. Finally they conclude that high real construction costs increase serial correlation in house prices but reduce mean reversion. They observe substantial over shooting of price trends, especially in the coastal cities of Boston, New York, San Francisco, Los Angeles, and San Diego.

Our objectives are more modest. We do not attempt to explain across metropolitan area variation in rates of house price appreciation and for convenience we work in nominal housing prices and interest rates. Measuring expected inflation and marginal tax rates is extremely difficult on an ex ante basis and so we opt for convenience.

Our objective is first develop a parsimonious model consisting of employment, nominal household income, and nominal interest rates, combined with lagged house prices to use in a model for explaining house price variation at the MSA level. To be clear, we use the same general model but identify parameters for each MSA separately. Next, we examine the sensitivity to mortgage rate and employment changes by using the locally determined coefficients.

We observe that some markets are highly sensitive to mortgage rate changes while others are not. This result is perplexing but provides some empirical insights into markets less likely to decline should mortgage rates increase significantly in the future.

Since Case and Shiller (1989), there have been a number of technical approaches to forecasting home prices. Recently Gu (2002) demonstrated that volatility and past appreciation rates influenced house price patterns. The point is not all markets behave in the same manner all the time. Prices may dip below or surge above fundamental values and the idea of reverting to a mean or intrinsic value over time should be further explored.

Data and Model

Historical median home price data from 1979 through 2003 along with personal income and employment data comes from http://www.economy.com. Mortgage interest rate data comes from Freddie Mac and Federal Reserve Bank reports. Annual data is used in the models shown here, although more frequent measurements are available such as quarterly data and monthly estimates.

The focus here is on using data that is readily available and reliable so that forecasts can become a contemporaneous exercise. Independent supply data, such a housing permits or starts, subject to significant noise and reporting lags, are not used but could easily be considered in future models that forecast yearly price changes. Shorter period forecasts, such as quarterly or monthly, are made more difficult when supply data is included as a result of the increased lags and noise compared to the other variables used here. We also do not quality adjust the data as size and age variables were not always available, but to the extent that median home prices are predictable with a fair degree of success one can be assured that quality adjusted models would do even better.

A Combined Fundamental and Technical Approach to Housing Prices at the MSA Level

Our approach is similar to that of Quigley (1999), Malpezzi (1999), Capozza, et al. (2004) and Abraham and Hendershott (1996) in that we combine fundamental and technical trends in our forecast. We differ in that we use as our long term equilibrium anchor a measure of intrinsic value based on a combination of affordable home values for the median income household in the local market and local employment trends. Unlike Abraham and Hendershott (1993, 1996) and Capozza, et al. (2004) we estimate separate fundamental and autoregressive house price models for each MSA. Therefore we do not attempt to identify the determinants of spatial variation either in real house price appreciation rates or in market adjustment processes. We recognize that this approach is demand-based rather than supply-based and that costs do matter, especially land costs. However, since we estimate house price model parameters separately for each MSA, the influence that high land prices have on house prices will be captured by the adjustment process for that city. Fundamentally, the model assumes that most of the temporal variation in nominal house prices, *for a given metropolitan area*, is determined by temporal variation in household incomes and employment. Our generalized model is a multiple regression equation where housing prices, HP, in time t are a function of an "intrinsic value", based on AP, the affordable price defined below, and two fundamental economic, E for employment and I for mortgage rates, as well as technical factors like prior house prices. β's represent regression coefficients. t-n indicates that various leads are used within the model from t to n years prior to the current year. Prices are all in nominal terms and there is no effort to decompose returns or compare housing returns to other assets. We used both log and non-log forms with similar results. The interaction between employment and mortgage rates, two of our key fundamental variables, was based on forecasts from http://www.economy.com. Our own results suggest an inverse correlation of approximately –0.35% using annual data over this period of time between mortgage rates and employment at the MSA level.

$$\ln \mathrm{HP}_t = \beta_1(\ln \mathrm{AP})_t + \beta_2(\ln E)_t + \beta_3(\ln(E{*}I)_t + \beta_4(\ln \mathrm{HP})_{t-1+\ldots+} \beta_5 (\ln \mathrm{HP})_{t-n} + \mathrm{ECT} + \varepsilon.$$

Here AP is calculated as follows:

$$\mathrm{AP} = \mathrm{HHMI}_{\mathrm{MSA}}/(3.3\mathrm{AMC}_{i,n}{*}\mathrm{LTV}),$$

where HHMI is the local MSA median household income; AMC is the annualized mortgage constant equal to the monthly mortgage constant times 12 for the current thirty year fixed rate mortgage, i, and term, n which effectively results in the present value of the payment stream or the supportable value of a mortgage using the local median income available for the debt service;[6] LTV is the loan to value ratio where 80% is used in the calculation of the affordable price, AP. *E* is the local MSA employment and *I* are the mortgage rates. HP is the house price in earlier periods as noted. ECT is an error correction term. We note the scaling assumptions used here in our affordable value measure are arbitrary, but they do provide some intuitive basis for the affordable values based on criteria suggested by Freddie Mac and the National Association of REALTORs, and therefore provide a reasonable index that parallels long run prices in most markets.

The affordable price calculation is used as an expression of what a marginal buyer could pay on average for a house in the local market. We note that some existing home buyers could not afford to buy the home they now live in and that those homebuyers who are older and later in the cycle may be able to put more money down than others, but the affordable home price derivation does a surprisingly good job of tracking home price trends over the long run especially when employment impacts are incorporated through what we call intrinsic value. Intrinsic value as defined here combines the AP plus the *E* and *I* terms above without the autoregressive terms. Tested over 316 markets using annual prices the intrinsic value model estimates are highly correlated with the actual home prices, more so in stable markets and less so in cyclical markets. Several examples of charts are shown in the appendix for major cities. See Figures A1-A4.

We tested several fundamental economic variables, but total employment worked as well as any and we report results using metropolitan employment below. Employment is an independent variable that is somewhat predictable, that is employment can be modeled separately in a two-stage forecast model with a great deal of success. Other economic models are possible with supply side variables like housing starts, yet starts are less predictable. The historical start data is less reliable and not available as quickly or cheaply, so there are some practical considerations that have gone into the model shown below.

With respect to the autoregressive terms, two period prior house price variables captured most of the cyclical trend and caught turning points in the general price trends. We tested the general model on all MSAs with a great deal of success even in cyclical coastal markets.

We estimated separate parameters for each of the 316 cities using annual data for the 1981-2002 period. We then used the estimated parameters to forecast 2003 house prices for each metropolitan area and report forecast

[6] The local income is divided by 3.3 to allow the household to spend up to 30% of income for initial mortgage payments.

errors below.

Results

The results for each of the 316 cities are available from the authors of this paper. Below we first examine more volatile markets like San Francisco (Figure 1) and San Diego (Figure 2), then look at a stable and highly predictable market like Cincinnati (Figure 3). Nominal San Francisco house prices have exhibited substantial volatility over the 1981-2002 period.

Figure 1: San Francisco housing price auto regressive with 2 time lags (AR(2)) model & forecast

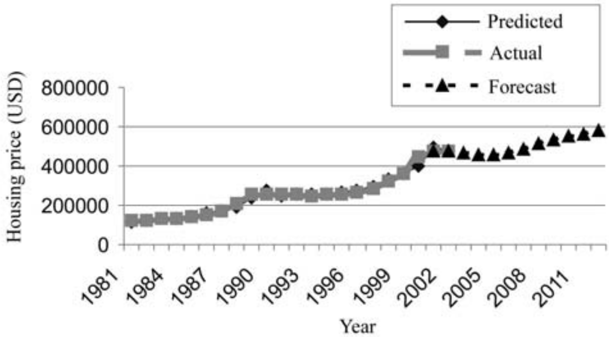
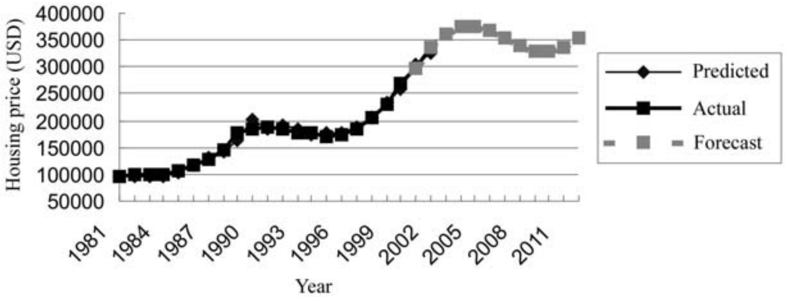


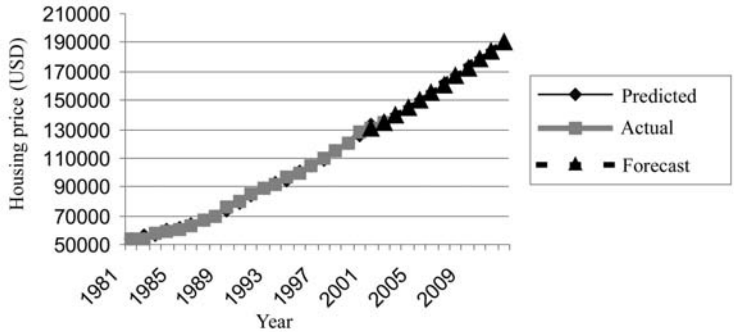
Figure 2: San Diego housing price AR(2) model & forecast



In markets like Cincinnati (Figure 3) and many others in the midwest, last year's price is virtually all that is needed to predict next year's price. The predicted and actual prices in Figure 3 are so close as to be virtually on top of one another. The Cincinnati market like many in the central part of the country show much less volatility than the coastal markets like Boston, New

York, San Diego, LA, and San Francisco.

Figure 3: Cincinnati A&E & price AR(2) model & forecast



Forecast Errors

We used the estimated parameters of the house price models to conduct an out of sample forecast of 2003 house prices and computed the prediction errors for these forecasts. The mean rate of house price appreciation for the 2002-2003 period was 7.01% for all 316 metropolitan areas and was 12.57% for coastal cities. The mean (absolute) forecast error for the 316 cities was 2.7% for all 316 cities and was 4.45% for coastal cities.[7]

Varying the Future Interest Rates

Using the MSA derived models we first varied interest rates to check the sensitivity of house prices. Two examples are provided in Figures 4 and 5 below for the LA and Boston markets with three interest rate scenarios going forward, 5%, 7%, and 10% for fixed rate 30 year mortgage financing. In the base case the mortgage rate is 6.0%. The effects are input by changing the affordable price result going forward and then brought into the housing price forecast through the overall model. The Employment variable was not changed in this particular illustration and will be varied below in the next set of results shown. The purpose here is simply to provide some quick visual results that show a response variation from one city to another from mortgage rate changes.

[7] The median absolute error was 1.86%. Our model is designed to capture both shorter term cyclical behavior as well as longer term reversion to mean from fundamental value influences. A better test will be based on how well these models do in the longer run with respect to income, interest rates and employment changes along with autoregressive cyclical influences.

Figure 4: Los Angeles median home prices and forecasts with three interest rate scenarios

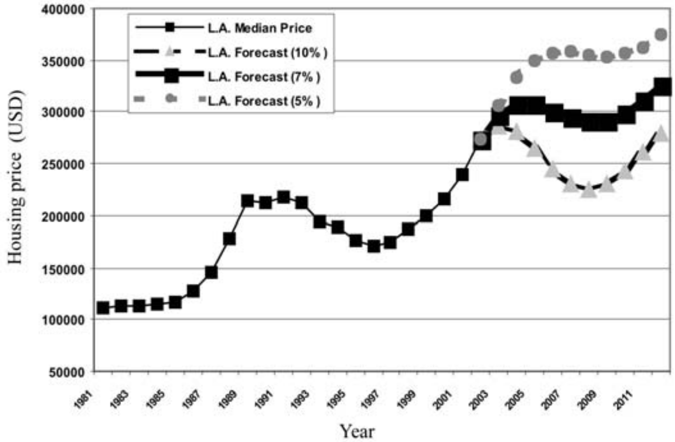
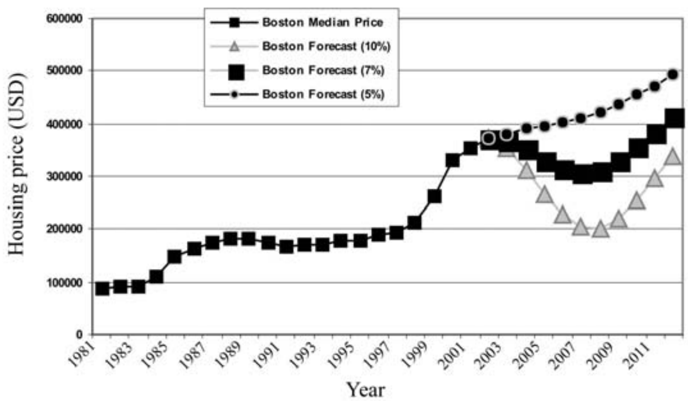


Figure 5: Boston median home price and forecast with three interest rate scenarios



Changing Mortgage Rates and Employment

We have been leading up to an examination of what could happen to housing prices if mortgage rates and simultaneously employment changed significantly. Our “base” case in based upon economy.com forecasts for each MSA in terms of employment and future interest rates. We also show IR, interest rates up or down and JL for job losses or job gains. Mortgage lenders go through a process of stress testing portfolios and the results below are intended to show the effects of a severe change in mortgage rates and or employment. The national market standard deviations for mortgage rates and the localized MSA-based standard deviations were calculated for each market tested. In the results shown below we increase/decrease mortgage rates two standard deviations or approximately 250 basis points, less than in the cases shown above but still significant. Employment changes vary by market but are also increased/decreased two standard deviations based on annual data from 1981 through 2004. In this model the interaction of the two variables, interest rates and employment, on housing prices was included in the results shown for several years into the forecast. We observe some markets peaking out earlier than others in terms of the maximum effects on home prices. Worst case comparison results are shown for 11 major MSAs below in Table 1.

Table 1: Maximum housing price declines from 2004 from an increase in mortgage rates and decrease in employment by two standard deviations for each MSA shown

MSA	Price decline (%)	Years out from 2004
Orange county	–15.3	4
Seattle	–10.9	4
San Diego	–10.5	3
New York	–8.8	5
Boston	–7.6	3
San Francisco	–7.3	3
Miami	–5.5	4
Denver	–5.0	3
Phoenix	–3.3	2
Chicago	–2.0	4
Dallas	–1.0	3

We see most MSAs peak out in about 3 years after an exogenous interest rate shock, although some markets are quicker like Phoenix and others slower like New York. The greatest change in price is shown in Orange County, shown in Figure 6, yet the base case for Orange County is a very modest price increase of only 5% (nominal) over 2004-2012. Overall results are shown for all eleven cities in Figure 7 from 2004 through 2012 from persistent changes in interest rates and employment. Denver is observed to be more sensitive to job losses while Miami and New York are more sensitive to mortgage rate increases. Chicago is affected equally by both. San Francisco where the base case suggests rather modest nominal appreciation of only 10% over several years is shown to be rather insensitive to the increase in mortgage rates and job losses. San Diego where the base case is only slightly better is shown to be more sensitive to job losses.

Figure 6: Orange county home price forecasts

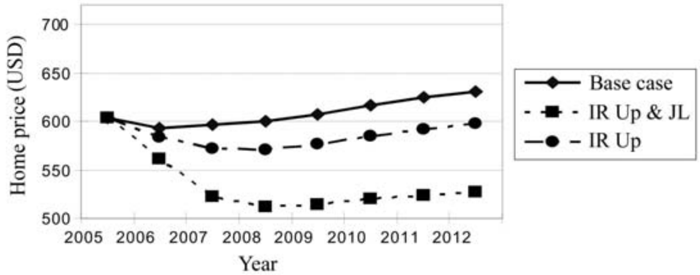
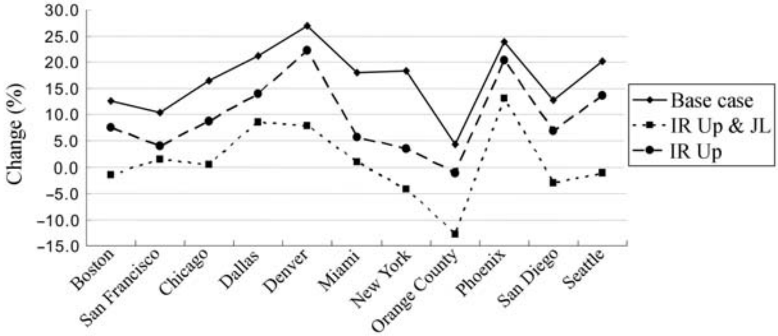


Figure 7: Percentage change (2004-2012): City comparison



The most sensitive cities to mortgage rate changes tended to be nearer the coasts where the use of ARMs (adjustable rate mortgages are more prevalent) and in general the least sensitive markets are in the mid parts of the country. However, several MSAs in Florida were not that sensitive to interest rates or employment changes. Theory tells us that markets where less debt is used should be less sensitive to interest rate changes but clearly more work needs to be done to fully understand the differences between how markets react to interest rate changes and why some markets, like those on both U.S. coasts where we observe significantly more price volatility and greater amplitude in cycles.

Conclusions

Much research has confirmed the predictability of home prices. Predictability and profit do not equate in the housing market the way such insights would benefit a stock trader. Until indices and instruments exist that allow for efficient hedging and separation of price risk from the cost of home occupancy it will remain difficult to benefit from such forecasts. Yet, predictability of future home prices provides great benefits to mortgage lenders. We observe that appreciation trends and default rates are inversely related and thus home price forecasts needs to be factored into the analysis of mortgage default risk. Responsiveness of home markets to fundamental economic changes allows for better mortgage portfolio stress testing. What we have shown here is that such responsiveness is localized and varies by market and also on a temporal basis. At the same time we do observe that all markets react, given enough time, to fundamental changes in mortgage rates and employment. Future research may be able to better explain the degree of responsiveness and the reasons that local markets respond at different rates and to different degrees.

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Appendix: Examples of House Prices vs. "Intrinsic Values"

Figure A1: San Francisco median and intrinsic values

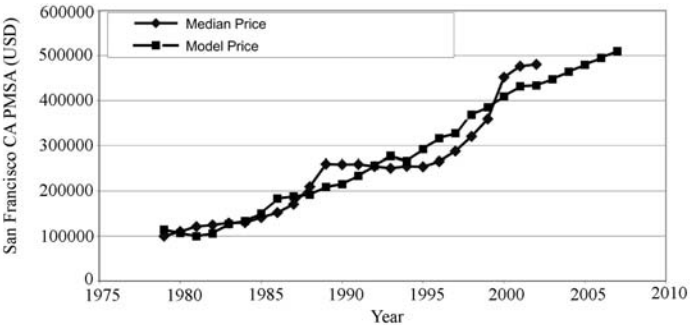


Figure A2: Cincinnati median and intrinsic values

While San Francisco tracks well it has greater cyclicality than stable markets like Cincinnati which track practically on top of one another.

Figure A3: Los Angeles median and intrinsic values

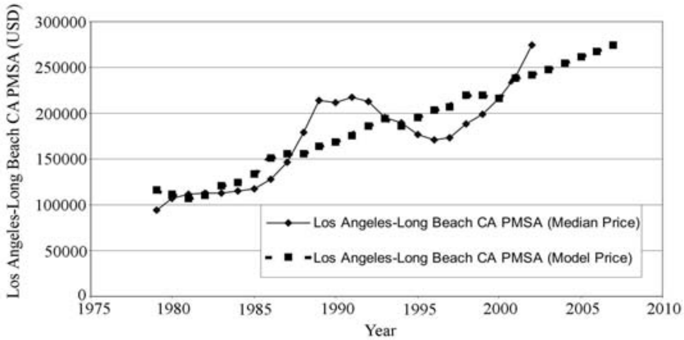
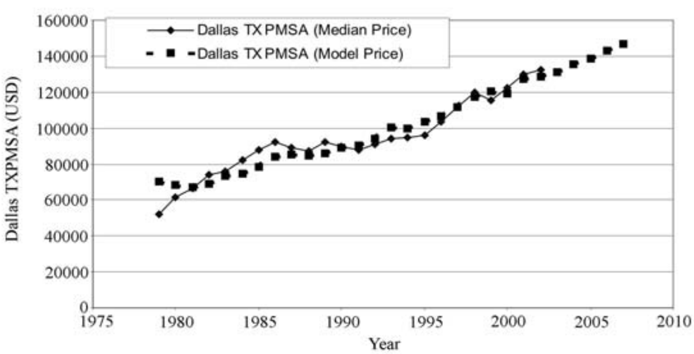


Figure A4: Dallas median and intrinsic values



Similar to San Francisco and Cincinnati we see that LA is fairly cyclical and Dallas much more aligned with intrinsic values.