# Idiosyncratic Volatility and the Housing Market

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**Abstract**

Housing investment is largely undiversified and differs from financial assets (e.g. stocks) in that it serves the dual purpose of investment and consumption. Transaction costs and liquidity risk are also much higher for housing assets. These important differences among financial and housing assets suggest that idiosyncratic volatility may play an important role in explaining investment returns in the U.S. housing market. We evaluate this hypothesis using disaggregate housing data based on the median-priced house sale in 7,234 zip codes comprising the U.S. metropolitan housing market. The analysis also allows us to determine the extent to which systematic and non-systematic risks influence investment returns in the U.S. housing market. Idiosyncratic volatility is estimated as the standard deviation of residuals from a two-factor regression of housing returns. We find that idiosyncratic volatility plays a strong positive role in housing returns and the relation is robust to the price level and socioeconomic variation among housing submarkets. Our results suggest that idiosyncratic volatility acts as an important reduced-form factor for local supply-demand conditions that operate autonomously of systematic economy-wide drivers.

**Keywords:** idiosyncratic volatility, housing investment returns, asset-pricing.

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## I. INTRODUCTION

Standard asset pricing theory suggests that idiosyncratic risk should not be priced in the returns of investment assets as this risk may be easily eliminated through diversification. Housing assets differ from financial assets such as stocks in that they serve the dual role of investment and consumption. Transaction costs and liquidity risk are also much higher for housing assets than for financial assets and, furthermore, few households are able to hold them in diversified holdings due to the large and lumpy nature of housing investment[1]. In fact, the vast majority of households own just one house and it is typically situated close to their employment location. Hence, investment decisions regarding housing assets are influenced by a different set of considerations than those relevant to financial assets.

These distinct features of housing assets and the implied lack of diversification suggest that idiosyncratic risk may play an important pricing role in the housing market. This paper empirically investigates the cross-sectional relation between idiosyncratic volatility and housing returns and is among the first papers to study this using an asset pricing approach with disaggregate zip-code level housing data. We also examine the impact of the house price-level on this relation and investigate its robustness to socioeconomic characteristics including income and unemployment.

Recent research has focused on the determinants of housing price dynamics and volatility (Capozza, Hendershott and Mack (2004), Malpezzi and Wachter (2005), Bourassa, Haurin, Hoesli and Sun (2005), Miller and Peng (2006)). The analysis of the paper also adds to this literature by enabling us to examine the extent to which both systematic and non-systematic risks influence the cross-section of returns in the U.S. housing market. If idiosyncratic volatility plays a strong role in submarket housing

[1]Housing represents more than half of net worth for most Americans. For example, Flavin and Yamashita (2002) show that among households with a head between 18 and 30 years old, 67.8% of their investment wealth is in their house.

returns, then this implies that returns to housing investment are significantly influenced by the interplay of local factors that are largely independent of systematic economy-wide drivers (e.g. stock market, overall housing market). Furthermore, the analysis also provides insights into whether exposure to systematic risk factors like the stock market and the overall housing market is positively or negatively priced in the U.S. housing market.

Our study uses disaggregate sales data on median-priced houses in 7,234 zip codes comprising the 155 metropolitan statistical areas (MSAs) of the United States. This data over 1996-2003 was obtained from the International Data Management Corporation (IDM). A number of recent studies use zip codes to define housing submarkets including Graddy (1997), Goodman and Thibodeau (1998, 2003), Decker, Nielsen and Sindt (2005) and Cannon, Miller and Pandher (2006). Empirical studies suggest that zip codes provide a reasonable spatial delineation for housing submarkets that correlates well with important hedonic factors impacting property values. For example, Goodman and Thibodeau (1998) propose a hierarchical hedonic model for estimating property values where housing submarket boundaries are based on public school quality. They find that the prediction mean square errors for (logged) house prices are very close when zip codes and the hedonic model are used to define neighborhoods (are 0.04335 and 0.0420, respectively). The authors conclude that "Indeed, given the arcane formulation of zip codes, it is surprising how well they characterize submarkets." Cannon, Miller and Pandher (2006) find a strong positive relation between housing returns and total volatility and report that MSA level analysis of housing returns removes 80% of the return variation present at the zip code level.

How submarkets are defined also has important implication for the estimation of idiosyncratic volatility. Since our measure of idiosyncratic volatility is based on the residuals of a two-factor asset pricing model, it is desirable to fit the model to relatively homogeneous housing markets to avoid over-inflation of residual variances. Since aggregation of housing returns to the level of MSAs amplifies our measure of idiosyncratic volatility and leads to information loss (there are an average of 46 zip codes per MSA in our sample), we also use zip codes to define housing submarkets as in the above studies.

We estimate submarket idiosyncratic volatility as the standard deviation of residuals from a two-factor regression that removes the systematic component of housing returns. The model views the medium-priced house in the zip code as our "stock" and is analogous to multi-factor asset pricing regressions such as the APT and the three-factor Fama-French model (Ross (1976) and Fama & French (1992)). It posits that systematic risk to housing returns arises from fluctuations in the stock and housing markets. The first factor represents the risk exposure of submarket housing investment to the stock market and may also be interpreted as the submarket's "economic risk" since the stock market is a leading indicator for the economy. The second factor represents the submarket risk exposure to fluctuations in the overall (national) housing market. The regression coefficients of the two-factor housing regression estimate the sensitivity of zip code housing returns to the S&P500 index and the overall housing market. After estimating the model for all 7,234 zip codes, we relate average housing returns to idiosyncratic volatility while controlling for the price level and socioeconomic variables. This is done using two-way sorts and cross-sectional regressions.

The paper provides several new insights and contributions to the empirical asset pricing literature on the U.S. housing market. First, we find that idiosyncratic volatility plays an important role in housing returns and its effect is positively priced in the U.S. metropolitan housing market. Housing investment in the highest idiosyncratic risk decile yields a 6.45% higher return relative to the lowest decile. Cross-sectional regression estimation suggests that a 10% increase in idiosyncratic volatility raises annual housing returns by 2.09%. Since housing investment is largely undiversified, this implies that non-systematic risk plays an important role in housing returns.

Second, the relation between housing returns and idiosyncratic volatility identified in the paper is robust to differences in socioeconomic characteristics among submarkets as they relate to income, employment rate, managerial employment, owner occupied housing, gross rent and population density. The relation is also robust to the clustering effects of metropolitan statistical areas that zip codes fall in. We investigate this by including MSA fixed effects in the cross-sectional regressions. While differences among the 155 metropolitan statistical areas (MSAs) explain 20% of the total return variation among zip codes, the inclusion of idiosyncratic volatility and price level explains an additional 35% of the total return variation.

Third, we find that exposure to systematic risks from both the stock and housing markets are negatively priced in the housing market. Therefore, submarkets with greater sensitivity to the stock market and the overall housing market provided lower returns over the 1996-2003 period. This suggests that the housing market offers a partial hedge to greater stock market exposure. Fourth, the return on housing investment is positively affected by the price-level, although this effect diminishes as the price level rises.

Recent work has focused on the determinants of housing price dynamics and volatility (Capozza, Hendershott and Mack (2004), Malpezzi and Wachter (2005), Bourassa, Haurin, Hoesli and Sun (2005) and others). Overall, our analysis shows that idiosyncratic volatility is an important asset pricing factor in housing returns and that it persists after controlling for differences in socioeconomic characteristics among housing submarkets (e.g. income, employment, rents, density). Idiosyncratic volatility appears to serve as a reduced-form factor for fluctuations in local housing supply-demand conditions that are unrelated to systematic economy-wide drivers (the stock market and the national housing market). Hence, our results support the view that investment returns in housing submarkets are strongly influenced by local factors and dynamics that operate autonomously of economy-wide systematic effects.

One tradeoff of using zip codes as the unit of analysis, is that while our sample has very rich cross-sectional depth (7,234 observations), the time series over 1996-2003 is somewhat short (national housing data at the zip code level does not exist pre-1996). In the cross-sectional regressions, we find that the regression coefficient for idiosyncratic volatility is strongly significant. This has the further implication that our results are robust to any measurement error in the independent variables since this leads to under-attenuation of the regression coefficients. Alternatively, if estimates from a shorter time series are seen as having larger sampling errors, then we are in the case of regression with stochastic regressors. Here, the cross-sectional depth of our sample ensures that our estimated coefficients are asymptotically unbiased[2]. Therefore, our specific findings and the size of the cross-sectional sample imply that our results are robust to econometric limitations posed by the length of the time series.

Our study differs from previous work on the characteristics of housing assets in several ways. While the literature examines the efficiency of the housing market, house price predictability and the dynamic relation of volatility and house prices within metropolitan areas, the focus of our study is on the cross-sectional role of idiosyncratic volatility on housing returns. The related financial and housing literature is surveyed below.

The financial economics literature reports mixed results on the cross-sectional role of idiosyncratic risk in explaining stock returns. In early empirical work, Douglas (1969) and Lintner (1965) find that the variance of the residuals from the market index model helps to explain the cross section of average stock returns. Tinic and West (1986),

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[2]This critical OLS condition for unbiased regression estimation is $E(\varepsilon \mid X) = \mathbf{0}$ where $\varepsilon$ is the regression error and $X$ are the regressors which may be stochastic (see White (1999, p. 20)). The size of the variance of $X$, however, is not relevant to the condition $E(\varepsilon \mid X) = \mathbf{0}$ as long as it is finite. With a cross-sectional sample of 7,234 observations, our resulting regression estimators are certainly asymptotically unbiased.

Lehmann (1990) and Malkiel and Xu (2003) present evidence of a positive relation between idiosyncratic volatility and stock returns while Ang, Hodrick, Xing and Zhang (2004) find a strongly significant difference of approximately -1% per year between the average return of the quintile portfolios with the highest and lowest idiosyncratic volatility. Meanwhile, Longstaff (1989) and Bali, Cakici, Yan and Zhang (2004) report that the estimated risk premium for idiosyncratic volatility is not significantly different from zero. In relation to this literature, our results show that non-diversifiable risk is positively and unambiguously priced in the housing market while its role in the stock market is not very clear.

A number of recent studies have examined the causes of housing price dynamics and volatility. Capozza, Hendershott and Mack (2004) explore the dynamics of housing price mean reversion and responses to various demand and supply variables for 62 metro areas from 1979 to 1995. They find heterogeneity in terms of the price trend responses to these economic variables based on the time period and the specific MSA. Malpezzi and Wachter (2005) examine supply constraints in the natural or political sense and demonstrate that price elasticity of supply plays a key role in housing volatility. They conclude that speculation has a greater role in causing price volatility when supply is less elastic. Bourassa, Haurin, Hoesli and Sun (2005) explore the causes of price variation within three New Zealand markets using a hedonic model and their analysis suggests that the bargaining power of buyers and sellers differs in strong versus weak markets and that price changes depend on the characteristics of the property. Using GARCH models and a panel VAR model, Miller and Peng (2006) find evidence of time-varying volatility in 17% of MSAs and find that volatility is Granger-caused by the home appreciation rate and GMP growth rate. Our study finds that idiosyncratic volatility is an important asset pricing factor in housing returns and its effect is robust to socioeconomic differences across submarkets. In relation to research on the determinants of housing price dynamics, our results suggest that idiosyncratic volatility acts as a reduced-form pricing factor for localized supply-demand shocks. The resulting idiosyncratic volatility leads to higher price appreciation in those submarkets. Meanwhile, we find that systematic risk exposures to the stock and overall housing markets have a negative effect on submarket returns.

While the focus of our study is cross-sectional and national, earlier work examines the temporal aspects of volatility and return within housing submarkets. Dolde and Tirtiroglu (1997) observe time-varying volatility and positive relations between conditional variance and returns in Connecticut and San Francisco over the period from 1971 to 1994. Dolde and Tirtiroglu (2002) identified 36 volatility events in four regional housing markets from 1975 to 1993 and suggest that price volatility surges are associated with changes in economic conditions. Case and Shiller (1989, 1990) find evidence of positive autocorrelation in real house prices based on weighted repeated sales price data for Atlanta, Chicago, Dallas and San Francisco during the 1970–1986 period. They also find that a trading rule based on purchasing a home when the forecasted price change exceeds the average price change generates modest trading profits of 1 to 3 percent for the four cities.

The remainder of the paper is organized as follows. Section II describes the data used in our study. The relation between housing returns, idiosyncratic volatility, price level and socioeconomic variables is investigated in Section III. Section IV concludes the paper.

## II. DATA

Our study uses disaggregate housing sales price and socioeconomic data for 7,234 zip codes defining the U.S. metropolitan housing market. These zip codes fall in 155 metropolitan statistical areas (MSAs) and our sample spans the period from 1996 through 2003. Annual data for median-priced house sales in zip codes is available at the national level from the International Data Management Corporation (IDM) only in the post-1995 period. Note that quality adjusted house prices (such as those provided by OFHEO, the Office of Federal Housing Enterprise Oversight) are not available at the zip code level.

Zip code level socioeconomic data from the 2000 census are obtained from the website maintained by the University of Missouri.[3] Socioeconomic data used in the study include median household income (*Inc*), the civilian unemployment rate (*Unemp*), percentage managerial employment (*Prof*), percentage of owner occupied housing (*Owner*), gross rent (*Rent*) and population density defined as persons per square mile (*Popsq*). The source of fixed rate mortgage data is Fidelity National Financial and Freddie Mac and the S&P500 index is obtained from Bloomberg.

Summary statistics are reported in Table I. The reported figures are first averaged over time and then averaged across zip codes. The average median house price (*Price*) across the 7,234 metropolitan zip codes is $188,845 while the average annualized housing return is 5.70% (*Return*). While house prices have a significant positive skew (3.330), the natural logarithm of house prices is relatively symmetric. The corresponding volatility (*Vol*) of median house price returns is 14.8%.

On average, the unemployment rate (*Unemp*) across zip codes over the sample period is 5.51%, 35.4% of the households have a member employed in a managerial occupation (*Prof*), 69.6% of the units are owner occupied (*Owner*) and the gross rent is $706. The average excess return of the S&P500 index is 9.55%, the average three-month T-Bill rate is 3.92% and the annualized monthly mortgage rate is 7.15%.

[3]See http://mcdc2.missouri.edu/websas/dp3_2kmenus/us

[Table I]

The sample period for the study exhibits substantial temporal heterogeneity with respect to economic conditions. Figure 1 plots the annual return on the S&P500 index over 1996 to 2003. Fluctuations in returns on the S&P500 index range from -22% to 33% and the sample period includes both bullish and bearish episodes for the stock market. The years 1996, 1997, 1998 and 1999 register strong positive stock market returns while strongly negative returns are observed over 2000, 2001 and 2002. In 2003, market returns rise and become positive again. There is also considerable heterogeneity in the returns of individual zip codes over the sample period. The minimum zip code return averaged over the period is -4.3% while the maximum return is 20.8%.

[Figure 1]

## III. IDIOSYNCRATIC VOLATILITY & HOUSING RETURNS

This section explores the relation between housing returns and idiosyncratic volatility in the U.S. metropolitan housing market. We also examine the impact of the house price-level on this relation and investigate whether the role of idiosyncratic volatility is robust to differences in socioeconomic characteristics among housing submarkets (e.g. income, unemployment, population density) and the clustering effect of MSAs. The analysis uses both two-way sorts and cross-sectional regressions.

### *A. Measuring Idiosyncratic Volatility in Housing Returns*

We estimate idiosyncratic volatility as the standard deviation of residuals from a two-factor asset pricing regression that removes the systematic component of housing returns. In the housing regression is analogous to multi-factor asset pricing regressions used in financial applications (e.g. APT of Ross (1976), the three-factor model of Fama & French (1992)) and views the median-priced house in the zip code as "the stock". The model posits two sources of systematic risk to submarket housing returns based on fluctuations in the stock and national housing markets.

The first factor reflects the risk exposure and sensitivity of zip code housing returns to the stock market. Since the stock market is a leading indicator for the economy, this factor may also be viewed as the housing submarket's "economic risk". The second factor represents the risk and sensitivity of housing submarkets to changes in the national housing market. In the regression estimation, zip code returns for the median-priced house sale are regressed on S&P500 index returns and the overall return in the national housing market. We estimate the two-factor model for all 7,234 zip codes and then relate housing returns to idiosyncratic volatility while controlling for the price level and socioeconomic variables.

Let $R_{it} = r_{it} - r_t^f$ represent the annual excess return on the median-price house sale in zip code $i = 1,...,n$ ( $\mathrm{n} = 7{,}234$) where the risk-free rate $r_t^f$ is the average annualized return on three-month T-Bills in year $t$. Idiosyncratic volatility (*Ivol*) for each housing submarket is estimated by the standard deviation of residuals in the following 2-factor regression

$$R_{it} = \alpha_0 + \beta_{Si} RSMKT_t + \beta_{Hi} RHMKT_t + \varepsilon_{it} \tag{1}$$

where

- $RSMKT_t$ is the excess annual return of the S&P500 index over the risk-free return in year *t*.
- $RHMKT_t$ is the excess annual return of the overall housing market in year *t*. It is calculated as the price-weighted housing return over 7,234 zip codes comprising the U.S. metropolitan housing market (155 MSAs)
- $\beta_S$ is the housing submarket's sensitivity to the stock market (stock market beta).
- $\beta_H$ is the housing submarket's sensitivity to the overall housing market (housing market beta).
- $\varepsilon$ is the standard Gaussian error.
- $Ivol_i$ is the standard deviation of estimated residuals from model (1) where *T* is the length of the time series:

$$Ivol_i = \sqrt{\frac{1}{T-1}\sum_{t=1}^{T}(\varepsilon_{it} - \bar{\varepsilon}_i)^2} = \sqrt{\frac{1}{T-1}\sum_{t=1}^{T}(\varepsilon_{it})^2} \; . \tag{2}$$

Figures 3 and 4 give an initial glimpse into the role of idiosyncratic volatility and price level on housing returns across the 7,234 zip codes of the U.S. metropolitan housing market. A discernable positive trend is apparent in both graphs, especially for idiosyncratic volatility.

[Figures 2 and 3]

### *B. Ranked Portfolios – Housing Returns by Price & Idiosyncratic Volatility*

After estimating the two-factor model for all 7,234 zip codes, we first examine how idiosyncratic volatility influences housing returns in portfolios based on 2-way sorts. For each year, zip codes are first sorted into ten ranked house price deciles (rows) and, then, within each price decile into ten ranked idiosyncratic volatility groups (columns).

Average annual housing returns by price level and idiosyncratic volatility combinations are reported in Panel A of Table II. The corresponding average idiosyncratic volatility *Ivol* and average house prices are reported in Panels B and C, respectively. "P-1" and "IV-1" are the low price and volatility deciles, respectively, while "P-10" and "IV-10" are the high price and volatility deciles.

Table II exhibits the cross-sectional relation between submarket housing returns, idiosyncratic volatility and the price-level in the U.S. housing market. First, note that housing returns increase uniformly from 5.81% to 12.26% over the lowest (IV-1) to the highest idiosyncratic volatility (IV-10) decile (top row of Panel A). Meanwhile, average volatility increases from 3.85% to 39.26% over the same deciles (top row of Panel B). Although the cross-sectional regressions in Tables III-VI examine this further, this is preliminary indication that idiosyncratic risk is positively priced in the U.S. housing market.

Second, the positive relation between idiosyncratic volatility and housing returns prevails uniformly at all price levels (rows "P-1" to "P-10"). Returns rise over increasing *Ivol* deciles in each price decile in Panel A. Third, the top row of Panel C suggests that the increases in housing returns with respect to idiosyncratic volatility is independent of the price-level as the average house price remains relatively flat over the idiosyncratic volatility deciles. The average house price ranges from $179,000 to $201,000 across the IV-1 to IV-10 deciles.

[Table II]

Fourth, we observe that housing submarkets with higher price levels yield higher returns. Housing returns increase from 5.02% to 10.47% over the lowest to highest price deciles ("All" column of Panel A). Lastly, the "ALL" column of Panel A and B shows that the positive effect of price-level on return is independent of volatility (which falls between 13.49% and 16.92%).

The ranked two-way results indicate a strong positive relation between both housing returns and idiosyncratic volatility and returns and the price-level. Furthermore, these effects are largely independent of each other.

### *C. Cross-Sectional Regressions*

We now consider cross-sectional regressions relating housing returns to idiosyncratic volatility in the 7,234 zip codes comprising the U.S. metropolitan housing market. Additional control variables in the regression include the average house price level, factor loadings (betas) for the stock and housing markets and socioeconomic variables.

The hypothesis that idiosyncratic risk is priced in the U.S. housing market is evaluated using cross-sectional regressions of the form

$$\begin{aligned} R_i = \alpha_0 + \alpha_1 Ivol_i + \alpha_2 In\operatorname{Pr}ice_i + \alpha_3 SBeta_i + \alpha_4 HBeta_i \\ + f(socioeconomic \operatorname{var}iables) + \varepsilon_t \end{aligned} \tag{3}$$

where

- $R_i$ is the average annual housing return for the housing submarket defined by zip codes $i = 1,...,7,234$.
- *Ivol* is the standard deviation of residuals from the two-factor regression (1).
- *LnPrice* is the average natural logarithm of house sales prices in the zip code (in $000s).

- $SBeta = \beta_S$ is the housing submarket's sensitivity to the stock market (stock market beta) estimated from (1).
- $HBeta = \beta_H$ is the housing submarket's sensitivity to the overall housing market (housing market beta) estimated from (1).
- *Socioeconomic variables* include zip-level variables from the 2000 census including log-income (*LnIncome*), employment rate (*Unemp*), managerial employment (*Prof*), percentage owner occupied housing (*Owner*), gross rent (*Rent*) and population density (*Popsq*).

We first consider the results from cross-sectional regressions based on (1) without socioeconomic controls in Table III. The regressions reveal that idiosyncratic volatility and the price level are positively priced in the U.S. housing market. The coefficient for *Ivol* in the three regressions falls in the range 0.19989 to 0.20846 and is highly significant. The estimates imply that returns to housing investment increase by nearly 2% in those submarkets where idiosyncratic volatility rises by 10%. The adjusted R-square with *Ivol* alone is 0.32 and rises to 0.46 and 0.54 with the inclusion of *lnPrice*, *SBeta* and *HBeta*.

Meanwhile, the regression coefficient for *lnPrice* implies that housing returns rise with the price level, although it has a diminishing effect. For example, a $400,000 house earns on average an additional 1.01% return annually than a house priced at $300,000 (0.02873[ln(400) – ln(300)]).

[Table III]

The above results indicate that idiosyncratic volatility captures important local submarket conditions in the housing market and serves as a reduced-form factor for submarket-specific dynamics. Idiosyncratic volatility is measured as the standard deviation of residuals in the two-factor asset pricing regression (1) that removes from housing returns the impact of systematic fluctuations in the stock and overall housing market. Idiosyncratic volatility rises when these systematic factors explain less of the observed variation in housing returns. It, therefore, captures the interplay of local supply-demand conditions that are unrelated to systematic economy-wide drivers.

### *D. Socioeconomic Variables & Quadratic Specification*

We now include socioeconomic variables in the cross-sectional regressions. This allows us to check if the positive relation between housing returns and idiosyncratic volatility is robust to differences in socioeconomic characteristics among submarkets due to income, unemployment, population density, etc. The analysis also gives additional insights into the role of these variables on housing returns.

The real estate economics literature suggests that socioeconomic factors, such as income and employment, influence housing investment returns. For instance, Ozanne and Thibodeau (1983) used socioeconomic variables as well as housing supply constraints to explain metropolitan price variation. At a more micro level, Goetzmann and Speigel (1997) estimate submarket price indices from repeat-sales metropolitan data in San Francisco using weighting functions based on spatial and socioeconomic characteristics. They find that median household income is the salient variable explaining the covariance of neighborhood housing returns. Dolde and Tirtiroglu (1997, 2002) report a positive relation between time-varying volatility and find that price volatility surges are associated with changes in economic conditions within submarkets. These and other studies suggest that it is important to check that the role of idiosyncratic volatility is robust to socioeconomic differences between submarkets.

The following variables for zip codes from the 2000 census are included in the cross-sectional regression (1): log-income (*LnIncome*), employment rate (*Unemp*), managerial employment (*Prof*), percentage owner occupied housing (*Owner*), gross rent

(*Rent*) and population density (*Popsq*). The results from the estimation are reported in Table IV.

[Table IV]

The estimation shows that the relation between housing returns and idiosyncratic volatility is robust to the inclusion of various combinations of socioeconomic variables. The coefficient for *Ivol* across the three model specifications is highly significant and falls in the narrow range of 0.19538 to 0.20067. Similarly, we find that the role of price level on returns remains positive and significant.

We also find that submarkets with higher unemployment have lower returns and that neighborhoods with a higher percentage of the labor force in managerial employment experience somewhat lower returns. For example, based on the estimate for the *Prof* coefficient in column F, the median priced house in a submarket where 70% of the labor force is employed in managerial professions is expected to yield a 3.1% lower annual return than an equivalent submarket with 20% employment in management. There is no obvious explanation for the second unexpected result. One possible conjecture for this empirical finding is that localities with higher household incomes form more exclusive submarkets that become relatively overvalued. This “herding” to exclusive neighborhoods created an ex-ante premium in the acquisition price that, subsequently, results in lower price appreciation.

Lastly, demand-supply proxies such as gross rents and population density have a positive affect on housing returns. The role of percentage of owner occupied units is, however, not statistically significant.

Table V estimates the cross-section regression (1) with quadratic terms for stock market and housing market betas ($SBeta^2$, $HBeta^2$ ). This analysis attempts to take into account the possibility that submarket housing returns may be affected non-linearly by exposure to the stock and housing markets. The estimation reveals that the coefficients for idiosyncratic volatility diminish in magnitude (0.16873, from 0.19989) but remains positive and highly significant. Similarly, the relation between returns and price level is also robust to the quadratic specification of stock and housing betas.

[Table V]

The above analysis reveals that our earlier result on the positive relation between housing returns and idiosyncratic volatility is not altered after controlling for differences in socioeconomic characteristics among submarkets and the quadratic specification. Housing returns still increase in submarkets with higher idiosyncratic volatility and price level.

### *E. Fixed Effects - Metropolitan Statistical Areas*

We now examine whether the positive relation between housing returns and volatility and price level is robust to the clustering effects from the 155 MSAs in which the 7,234 zip-codes fall. The analysis is motivated by the finding of Goetzmann, Spiegel and Wachter (1998) who define neighborhoods using zip codes and show that when two properties are separated in space but perceived by the market as substitutes for each other, their prices also fluctuate together. We account for these effects by including fixed effects for the MSAs in the cross-sectional regressions of housing returns on volatility and price level (Table III). The results of this estimation are reported in Table VI.

[Table VI]

The coefficients for idiosyncratic volatility and price level continue to remain positive and highly significant after the inclusion of the MSA fixed effects. The last column of Table V shows the coefficient for idiosyncratic volatility remains effectively unchanged at 0.20512 (from 0.19989, Table III), while the price level effect diminishes to 0.01551 (from 0.02873).

Lastly, MSAs alone explain only 20.8% of the total return variation among zip codes and the inclusion of idiosyncratic volatility and price level explains an additional 35% of the housing return variation. This suggests that the relation between returns, idiosyncratic volatility and price level holds after removing the MSA clustering effect and that a large part variation in zip code level returns is left unexplained by MSA-level analysis.

## VI. SUMMARY & CONCLUSION

Due to the elimination of idiosyncratic risk in diversified portfolios, standard asset pricing theory suggests that there should be no risk-premium for idiosyncratic risk in investment assets. Housing assets, however, differ from financial assets in many respects such as their dual use for consumption and investment, higher transaction costs, higher liquidity risk and economic constraints on holding diversified housing investment for most households. These observations suggest that idiosyncratic volatility may play a significant asset-pricing role in returns to housing investment.

Our study empirically investigates this hypothesis using disaggregate data on median-priced house sales in 7,234 zip codes comprising the U.S. metropolitan housing market (155 metropolitan statistical areas). The analysis also enables us to examine the extent to which systematic and non-systematic risks influence investment returns in the U.S. housing market. Idiosyncratic volatility is estimated as the standard deviation of residuals from a two-factor asset pricing regression which removes the systematic component of housing returns due to the stock market and national real estate market. Our results provide a number of new insights into the role of idiosyncratic volatility and systematic factors in the U.S. housing market.

We find that idiosyncratic volatility is positively and significantly priced in the U.S. metropolitan housing market. For example, housing investment in the highest idiosyncratic risk decile yields a 6.45% higher average return than the lowest decile. Similarly, cross-sectional regression estimation reveals that a 10% increase in idiosyncratic volatility raises housing returns annually by 2.09%. Since housing investment is largely undiversified, this result implies that undiversified risk is compensated with higher returns in the real estate market. Moreover, the positive relation holds uniformly at all price levels and is robust to socioeconomic characteristics, including income and employment, and metropolitan clustering effects. While differences among the 155 metropolitan statistical areas (MSAs) explain 20% of the total return variation among zip codes, the inclusion of idiosyncratic volatility explains an additional 35% of the total return variation.

The analysis also reveals that housing submarkets with greater sensitivity to the stock market and the overall housing market exhibit lower returns. Since the stock market is a leading indicator for the economy, the housing submarket's sensitivity to the stock market is a measure of its "economic risk". Our results show that this economic risk is negatively priced in housing returns over the sample period from 1996-2003 and suggests that the housing market offers a partial hedge to stock market exposure.

Lastly, research including Capozza, Hendershott and Mack (2004), Malpezzi and Wachter (2005), Bourassa, Haurin, Hoesli and Sun (2005) and Miller and Peng (2006) focuses on the determinants of housing price dynamics and volatility. This study shows that idiosyncratic volatility is an important asset pricing factor in explaining the cross-section of housing returns, and that its role is robust to socioeconomic differences among housing submarkets. Furthermore, our analysis suggests that housing returns are strongly influenced by local submarket conditions and that idiosyncratic volatility may be viewed as an important reduced-form factor for local supply-demand dynamics that operate autonomously of systematic economy-wide drivers (e.g. the stock market and the national housing market).

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## Table I. Summary Statistics

Data sources for our study include the International Data Management Corporation (IDM) for house price data, Bloomberg for the S&P500 index, and the University of Missouri for zip code level 2000 census socioeconomic data (http://mcdc2.missouri.edu/websas/dp3_2kmenus/us). IDM data consists of prices for the median-priced house sale in the 7,234 zip codes comprising the U.S. metropolitan housing market (155 metropolitan statistical areas). This annual data series is over the 1996-2003 period (disaggregate zip code data is available only in the post-1995 period).

The reported figures are means obtained by first averaging over the sample period and then averaging over zip codes. *Price* is the median house price in the zip code (in $000s), *Return* is the annual return on the median-priced house sale, *Income* is the median household income, *Prof* is the percentage of employed in managerial occupations, *Unemp* is the employment rate, *Owner* is the percentage of owner-occupied housing units, *Rent* is the gross median rent, *Popsq* is the number of persons per square mile. The *Risk-Free Rate* is the average monthly annualized return for three-month T-Bills and *Mortgage Rate* is the same for monthly mortgage rates.

| | **Obs** | **Mean** | **Median** | **Std** | **Min** | **Max** | **Kurt** | **Skew** |
|---|---|---|---|---|---|---|---|---|
| Price ($000s) | 7234 | 188.845 | 147.462 | 1.753 | 34.480 | 1857.14 | 18.099 | 3.330 |
| Return (%) | 7234 | 5.695 | 4.595 | 2.878 | -4.284 | 20.849 | 0.452 | 0.785 |
| RSP500 (%) | 8 | 9.552 | 17.473 | 7.429 | -23.367 | 33.303 | -1.480 | -0.558 |
| Risk-Free Rate (%) | 8 | 3.919 | 4.700 | 0.610 | 1.117 | 5.814 | -0.738 | -0.896 |
| Mortgage Rate (%) | 8 | 7.146 | 7.201 | 0.259 | 5.819 | 8.063 | 0.069 | -0.678 |
| Income | 7173 | 51,700 | 48,373 | 242 | 7,619 | 200,001 | 3.999 | 1.391 |
| Prof | 7171 | 35.385 | 33.550 | 0.156 | 0 | 100 | -0.134 | 0.521 |
| Unemp | 7171 | 5.512 | 4.327 | 0.049 | 0 | 76.1561 | 24.979 | 3.343 |
| Owner | 7173 | 69.624 | 73.376 | 0.212 | 1.4091 | 100 | 0.546 | -0.928 |
| Rent | 7155 | 706 | 663 | 2.777 | 193 | 2001 | 4.316 | 1.552 |
| Popsq | 7173 | 2885 | 1425 | 50.900 | 0.630 | 69013 | 34.553 | 4.360 |

## Table II. Housing Returns by Idiosyncratic Volatility and Price Level

Idiosyncratic volatility (*Ivol*) is estimated as the standard deviation of residuals from a two-factor asset pricing regression. The model posits two sources of systematic risk to housing returns driven by fluctuations in the stock and national housing markets. It views the median-priced house sale in each zip code as "the stock" and is analogous to multi-factor asset-pricing regressions such as the APT of Ross (1976) and the three-factor model of Fama & French (1992). In estimation, housing returns in zip codes are regressed on returns to the S&P500 index and the overall housing market:

$$R_{it} = \alpha_0 + \beta_{Si} RSMKT_t + \beta_{Hi} RHMKT_t + \varepsilon_{it} \tag{1}$$

where $R_{it} = r_{it} - r_t^f$ is the annual excess return on the median-price house sale in zip code $i = 1,...,n$ ($n$ = 7,234) in year $t$, $r_t^f$ is the annualized return on three-month T-Bills, $RSMKT_t$ is the excess annual return of the S&P500 index, and $RHMKT_t$ is the excess annual return of the U.S. housing market (calculated as the price-weighted housing return over the 7,234 zip codes).

After estimating the two-factor model for all the 7,234 zip codes, zip codes are first sorted into ten ranked price deciles (rows) every year and, then, within each price decile, into ten idiosyncratic volatility deciles (columns). "P-1" and "IV-1" represent the lowest house price and idiosyncratic volatility deciles, respectively, while "P-10" and "IV-10" are the highest deciles. The reported figures are yearly averages for housing returns (Panel A), idiosyncratic volatility (Panel B) and average house price (Panel C). The first row and column of each panel reports overall averages for the price and idiosyncratic volatility deciles, respectively.

| | All | IV-1 | IV-2 | IV-3 | IV -4 | IV-5 | IV-6 | IV-7 | IV-8 | IV-9 | IV-10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *Panel A: Average Yearly House Price Return (%)* | | | | | | | | | | | |
| All | | 5.81 | 6.09 | 6.28 | 6.57 | 6.90 | 6.95 | 7.35 | 7.91 | 9.04 | 12.26 |
| P-1 | 5.02 | 3.29 | 3.93 | 3.26 | 3.74 | 3.82 | 4.16 | 4.60 | 5.57 | 6.21 | 11.70 |
| P-2 | 5.90 | 4.32 | 3.96 | 4.82 | 4.14 | 4.28 | 4.74 | 5.39 | 5.52 | 7.71 | 14.20 |
| P-3 | 6.46 | 4.59 | 4.78 | 5.19 | 5.02 | 4.69 | 5.11 | 5.39 | 6.45 | 8.51 | 14.97 |
| P-4 | 6.46 | 4.29 | 5.08 | 4.87 | 4.97 | 4.98 | 5.84 | 6.23 | 6.56 | 7.95 | 13.86 |
| P-5 | 7.21 | 4.79 | 5.24 | 5.99 | 6.53 | 6.18 | 6.62 | 6.81 | 6.87 | 8.38 | 14.77 |
| P-6 | 7.32 | 5.28 | 5.43 | 6.09 | 6.14 | 6.78 | 6.64 | 7.66 | 7.37 | 8.69 | 13.19 |
| P-7 | 8.25 | 6.84 | 6.58 | 6.45 | 6.61 | 6.70 | 8.03 | 7.08 | 9.23 | 9.71 | 15.29 |
| P-8 | 8.99 | 7.23 | 7.40 | 7.42 | 7.56 | 7.99 | 8.19 | 8.12 | 9.43 | 10.39 | 16.23 |
| P-9 | 9.03 | 7.56 | 8.04 | 8.08 | 8.24 | 8.71 | 8.12 | 8.58 | 8.59 | 9.91 | 14.54 |
| P-10 | 10.47 | 8.85 | 8.68 | 9.30 | 9.02 | 9.32 | 10.14 | 9.93 | 10.32 | 11.22 | 17.95 |
| *Panel B: Average Idiosyncratic Volatility (%)* | | | | | | | | | | | |
| All | | 3.85 | 5.75 | 7.29 | 8.73 | 10.34 | 12.25 | 14.56 | 17.74 | 23.24 | 39.26 |
| P-1 | 17.22 | 4.06 | 6.08 | 7.92 | 9.78 | 11.94 | 14.32 | 17.66 | 22.39 | 29.86 | 48.50 |
| P-2 | 16.19 | 3.62 | 5.60 | 7.12 | 8.60 | 10.06 | 12.29 | 15.51 | 19.80 | 28.34 | 51.28 |
| P-3 | 15.33 | 3.24 | 5.14 | 6.42 | 7.77 | 9.35 | 11.15 | 13.89 | 18.48 | 27.25 | 50.90 |
| P-4 | 13.47 | 2.98 | 4.71 | 5.83 | 6.89 | 8.30 | 10.20 | 13.02 | 16.83 | 23.02 | 43.14 |
| P-5 | 13.60 | 3.22 | 4.63 | 5.89 | 7.01 | 8.29 | 10.04 | 12.73 | 16.94 | 23.49 | 43.98 |
| P-6 | 12.35 | 2.99 | 4.32 | 5.35 | 6.46 | 7.69 | 9.27 | 11.38 | 14.51 | 19.77 | 42.02 |
| P-7 | 13.27 | 3.33 | 4.65 | 5.64 | 6.71 | 7.95 | 9.66 | 11.86 | 15.10 | 21.60 | 46.41 |
| P-8 | 13.62 | 3.19 | 4.63 | 5.77 | 6.81 | 7.84 | 9.23 | 11.57 | 15.21 | 22.38 | 49.87 |
| P-9 | 12.96 | 3.40 | 4.88 | 5.96 | 7.11 | 8.24 | 9.46 | 11.43 | 14.48 | 21.61 | 43.22 |
| P-10 | 14.78 | 4.52 | 6.28 | 7.50 | 8.58 | 9.78 | 11.49 | 13.61 | 16.75 | 23.05 | 46.48 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *Panel C: Average Price (in $1000)* | | | | | | | | | | | |
| All | | 179 | 176 | 190 | 204 | 198 | 208 | 194 | 198 | 200 | 201 |
| P-1 | 60 | 62 | 61 | 59 | 60 | 58 | 57 | 59 | 59 | 59 | 62 |
| P-2 | 84 | 84 | 84 | 83 | 85 | 84 | 83 | 83 | 83 | 85 | 86 |
| P-3 | 103 | 103 | 102 | 102 | 103 | 102 | 102 | 102 | 103 | 103 | 105 |
| P-4 | 120 | 120 | 120 | 119 | 120 | 120 | 121 | 120 | 120 | 121 | 123 |
| P-5 | 141 | 138 | 140 | 141 | 140 | 141 | 141 | 140 | 140 | 142 | 145 |
| P-6 | 164 | 163 | 163 | 163 | 162 | 164 | 162 | 164 | 164 | 165 | 166 |
| P-7 | 193 | 192 | 192 | 192 | 189 | 193 | 195 | 194 | 194 | 194 | 199 |
| P-8 | 234 | 237 | 231 | 232 | 232 | 235 | 232 | 230 | 234 | 237 | 238 |
| P-9 | 299 | 292 | 296 | 291 | 302 | 300 | 299 | 301 | 300 | 302 | 307 |
| P-10 | 550 | 472 | 466 | 525 | 554 | 545 | 500 | 566 | 589 | 606 | 683 |

## Table III. Cross-sectional Regressions of Housing Returns on Idiosyncratic Volatility

In the cross-sectional regressions, average house returns in the 7,234 zip codes of the U.S. metropolitan housing market are regressed on idiosyncratic volatility, market price and controls for socioeconomic variables. First, idiosyncratic volatility (*Ivol*) is estimated as the standard deviation of residuals from a two-factor asset pricing regression. The model posits two sources of systematic risk to housing returns driven by fluctuations in the stock and national housing markets. It views the median-priced house sale in each zip code as "the stock" and is analogous to multi-factor asset-pricing models such as the APT of Ross (1976) and the three-factor model of Fama & French (1992). In estimation, housing returns in zip codes are regressed on returns to the S&P500 index and the overall housing market:

$$R_{it} = \alpha_0 + \beta_{Si} RSMKT_t + \beta_{Hi} RHMKT_t + \varepsilon_{it} \tag{1}$$

where $R_{it} = r_{it} - r_t^f$ is the annual excess return on the median-price house sale in zip code $i = 1,...,n$ ($n = 7{,}234$) in year $t$, $r_t^f$ is the annualized return on three-month T-Bills, $RSMKT_t$ is the excess annual return of the S&P500 index, and $RHMKT_t$ is the excess annual return of the U.S. housing market (calculated as the price-weighted housing return over the 7,234 zip codes).

After estimating the two-factor model for all 7,234 zip codes, average housing returns are related to idiosyncratic volatility using the following cross-sectional regression:

$$R_i = \alpha_0 + \alpha_1 Ivol_i + \alpha_2 In\Pr ice_i + \alpha_3 SBeta_i + \alpha_4 HBeta_i + \varepsilon_t \tag{3}$$

where $R_i$ is the average annual housing return for each zip codes $i = 1,...,7{,}234$ over 1996-2003, *LnPrice* is the mean of the log house price (in $000s), $SBeta = \beta_S$ is the sensitivity of housing returns to the stock market and $HBeta = \beta_H$ is the sensitivity of housing returns to the overall housing market.

| | **Estimate** | **t-value** | **Estimate** | **t-value** | **Estimate** | **t-value** |
|---|---|---|---|---|---|---|
| ***Intercept*** | 0.04633 | (69.93) | -0.09770 | (-28.53) | -0.09583 | (-30.14) |
| ***Ivol*** | 0.20091 | (58.68) | 0.20846 | (68.09) | 0.19989 | (68.24) |
| ***lnPrice*** | | | 0.02837 | (42.7) | 0.02873 | (46.46) |
| ***SBeta*** | | | | | -0.01117 | (-6.48) |
| ***HBeta*** | | | | | -0.00256 | (-21.11) |
| | | | | | | |
| **R-Square** | 0.3249 | | 0.4620 | | 0.5362 | |
| **RMSE** | 0.03831 | | 0.0342 | | 0.03175 | |

## Table IV. Cross-sectional Regressions with Socioeconomic Variables

Socioeconomic variables for income, managerial employment, employment rate, owner occupied housing, rent, population density at the zip-code level are included in the cross-sectional regressions of housing returns on idiosyncratic volatility in Table III. The cross-sectional regression has the form

$$R_i = \alpha_0 + \alpha_1 Ivol_i + \alpha_2 In\Pr ice_i + \alpha_3 SBeta_i + \alpha_4 HBeta_i + f(socioeconomic \operatorname{var} iables) + \varepsilon_t$$

where socioeconomic variables include the following variables: *LnIncome* is the natural-log of median household income in the zip code, *Unemp* is the employment rate, *Prof* is the percentage of employed in managerial occupations, *Owner* is the percentage of owner-occupied housing units, *Rent* is the gross median rent, *Popsq* is the number of persons per square mile. The socioeconomic data is from the 2000 census. The cross-sectional regression is estimated using 7,155 metropolitan zip codes (79 of the original 7,234 zip codes did not match the corresponding socioeconomic data).

| | **Estimate** | **t-value** | **Estimate** | **t-value** | **Estimate** | **t-value** |
|---|---|---|---|---|---|---|
| ***Intercept*** | 0.08533 | 7.07 | -0.000953 | -0.05 | -0.0364 | -1.71 |
| ***Ivol*** | 0.19538 | 67.47 | 0.19578 | 68.32 | 0.20067 | 68.13 |
| ***lnPrice*** | 0.03797 | 44.62 | 0.04325 | 45.81 | 0.04061 | 37.19 |
| ***SBeta*** | -0.00989 | -5.83 | -0.00899 | -5.34 | -0.00784 | -4.65 |
| ***HBeta*** | -0.00264 | -22.09 | -0.00268 | -22.6 | -0.00278 | -23.34 |
| ***lnIncome*** | -0.02106 | -15.53 | -0.01358 | -7.68 | -0.01666 | -6.24 |
| ***Unemp*** | | | -0.01427 | -1.23 | -0.02510 | -2.14 |
| ***Prof*** | | | -0.05689 | -12.66 | -0.06241 | -13.27 |
| ***Owner*** | | | | | 0.00052 | 0.14 |
| ***Rent*** | | | | | 0.01174 | 5.31 |
| ***Popsq*** | | | | | 0.00102 | 3.65 |
| | | | | | | |
| **R-Square** | 0.5513 | | 0.5611 | | 0.5650 | |
| **RMSE** | 0.03123 | | 0.03089 | | 0.03075 | |

## Table V. Inclusion of Quadratic Betas in the Cross-sectional Regressions

Quadratic terms for the stock market beta and housing market beta are included in the cross-sectional regressions of housing returns in Tables III and IV.

| | Estimate | t-value | Estimate | t-value | Estimate | t-value |
|---|---|---|---|---|---|---|
| ***Intercept*** | -0.09770 | -28.53 | -0.09290 | -29.72 | -0.03275 | -1.57 |
| ***Ivol*** | 0.20846 | 68.09 | 0.16873 | 46.94 | 0.17079 | 47.45 |
| ***lnPrice*** | 0.02837 | 42.7 | 0.02837 | 46.81 | 0.04008 | 37.39 |
| ***SBeta*** | | | -0.01383 | -8.06 | -0.01046 | -6.22 |
| ***SBeta***$^2$ | | | 0.00839 | 4.73 | 0.00818 | 4.75 |
| ***HBeta*** | | | -0.00203 | -15.84 | -0.00228 | -18.07 |
| ***HBeta***$^2$ | | | 0.00011 | 13.71 | 0.00010 | 13.05 |
| ***lnIncome*** | | | | | -0.01593 | -6.08 |
| ***Unemp*** | | | | | -0.02351 | -2.04 |
| ***Prof*** | | | | | -0.05999 | -12.99 |
| ***Owner*** | | | | | 0.00008 | 0.02 |
| ***Rent*** | | | | | 0.01064 | 4.91 |
| ***Popsq*** | | | | | 0.00085 | 3.10 |
| | | | | | | |
| **R-Square** | 0.462 | | 0.5547 | | 0.5811 | |
| **RMSE** | 0.0342 | | 0.03111 | | 0.03018 | |

## Table VI. MSA Fixed Effects & Idiosyncratic Volatility

Fixed effects for Metropolitan Statistical Areas (MSAs) are included in the cross-sectional regressions of housing returns on idiosyncratic volatility in Table III. The 7,234 metropolitan zip codes in the sample fall into 155 MSAs. The first row in the "F/t-value" is the F-value for the MSA effects while the other rows are t-values for the estimated regression coefficients.

| | **Estimate** | **F/t-value** | **Estimate** | **F/t-value** | **Estimate** | **F/t-value** |
|---|---|---|---|---|---|---|
| ***MSA Fixed Effects*** | Yes | 12.07 | Yes | 21.82 | Yes | 28.29 |
| ***Intercept*** | | | 0.03790 | 40.75 | -0.03227 | -8.14 |
| ***Ivol*** | | | 0.22606 | 75.63 | 0.20512 | 75.34 |
| ***lnPrice*** | | | | | 0.01551 | 19.74 |
| ***SBeta*** | | | | | 0.00392 | 2.43 |
| ***HBeta*** | | | | | -0.00360 | -30.98 |
| **R-Square** | 0.20796 | | 0.56197 | | 0.66225 | |
| **RMSE** | 0.04239 | | 0.03153 | | 0.07512 | |

**Figure 1. Returns on the S&P500 Index by Year**

Annual returns on the S&P500 index (*RSP500*) are plotted over the sample period from 1996 to 2003.

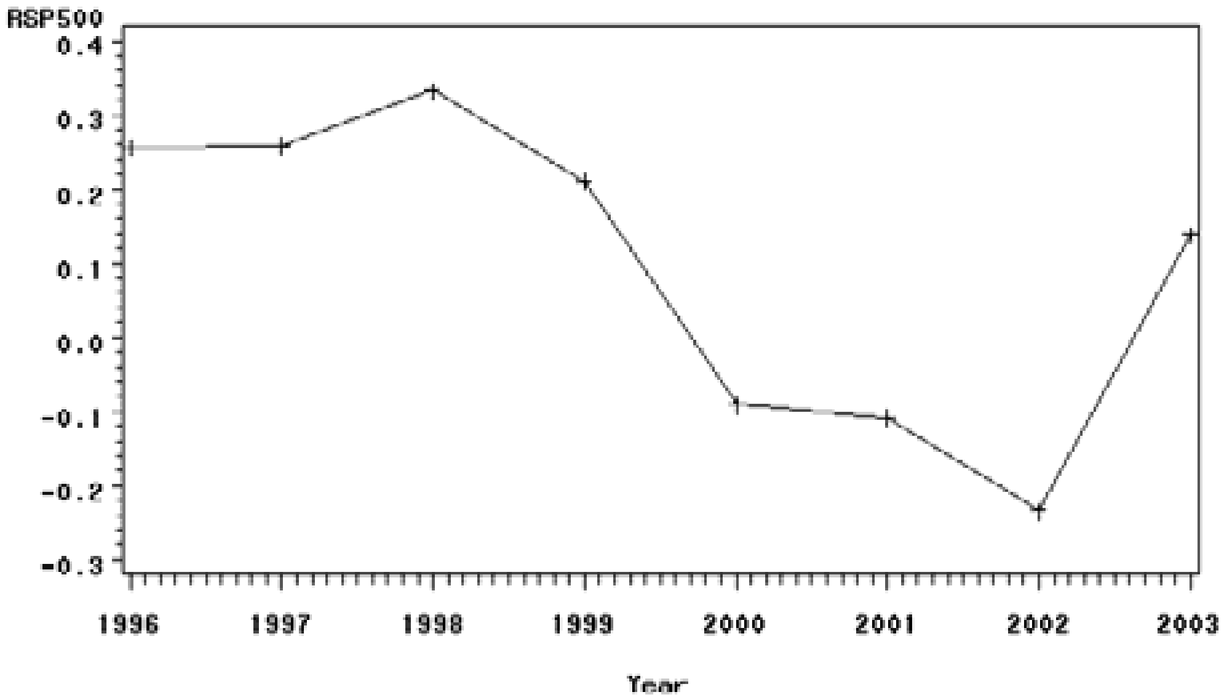
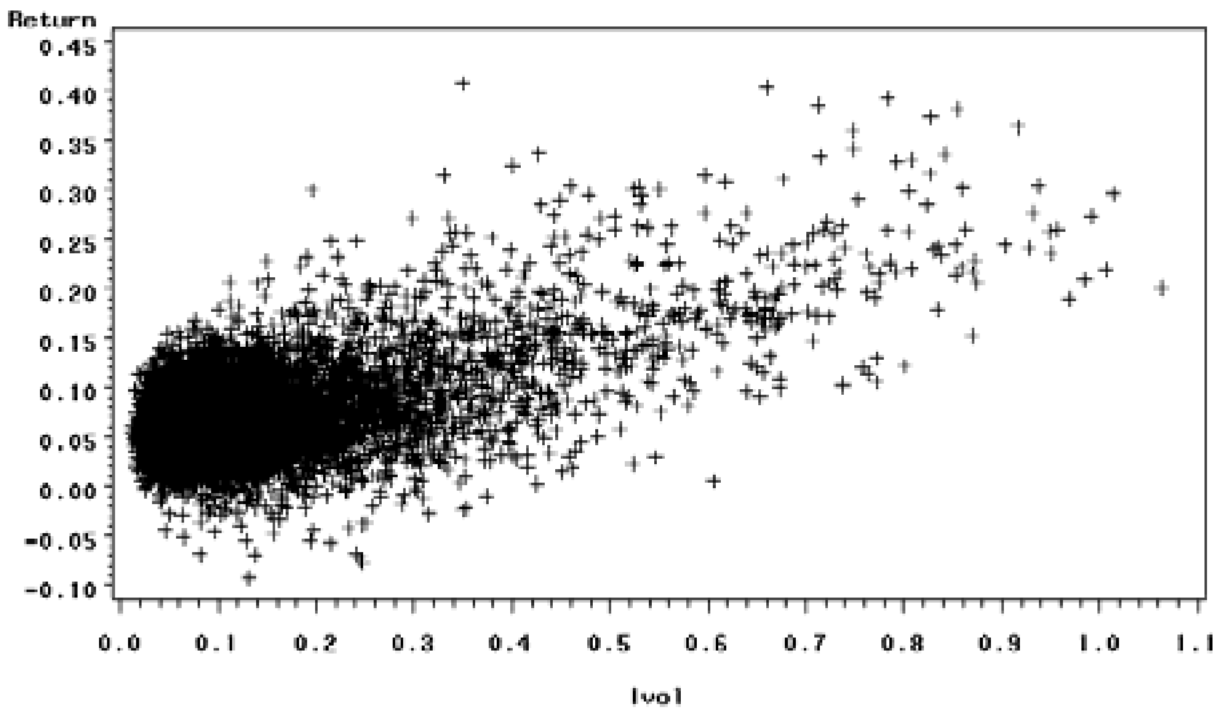


**Figure 2. Idiosyncratic Volatility & Housing Returns**

*Return* is the average annual housing return over 1996-2003 for the 7,234 zip-codes comprising the U.S. metropolitan housing market. Idiosyncratic volatility (*Ivol*) is estimated as the standard deviation of residuals from the 2-factor housing regression model (1).



## Figure 3. Return and Price-level in the U.S. Metropolitan Housing Market

*Return* is the average annual housing return over 1996-2003 for the 7,234 zip-codes in the U.S. metropolitan housing market. *LnPrice* is the average of logged house prices ($000s) in each zip code.