

**WORKING PAPER NO. 96-16**  
**RISK AND RETURN**  
**IN THE SINGLE-FAMILY HOUSING MARKET**

Theodore M. Crone  
and  
Richard P. Voith

Federal Reserve Bank of Philadelphia

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## Abstract

The tradeoff between risk and return in equity markets is well established. This paper examines the existence of the same tradeoff in the single-family housing market. For home buyers, who constitute about two-thirds of U.S. households, the choice about how much housing and which house to buy is a joint consumption/investment decision. Does this consumption/investment link negate the risk/return tradeoff within the single-family housing market? Theory suggests the link still holds. This paper supplies empirical evidence in support of that theoretical result.

The largest single investment for most American families is the house in which they live. And for the majority, the decision about whether to buy a house and which house to buy is at least partially influenced by the property's investment potential or the expected rate of return (Case and Shiller, 1988). About two-thirds of U.S. households have opted to own their homes despite the fact that the long-run, pre-tax return on residential real estate has historically been lower than the return on a representative portfolio of stocks (Ibbotson and Siegel, 1984; Goetzmann and Ibbotson, 1990). One reason that households are willing to invest in owner-occupied housing is that the U.S. tax code encourages such investment by not taxing the implicit rent that homeowners receive, yet allowing certain costs of ownership, such as mortgage interest payments and property taxes, to be deducted from other income. Thus, the tax advantages of homeownership link the consumption and investment decision in housing.

Another reason why households may still be willing to invest in housing despite the lower average return is that housing is a less risky investment than stocks, that is, the return to housing is less volatile than the return to stocks.<sup>1</sup> Our purpose in this paper is not to compare the risk and return for residential real estate to that for other investments but rather to examine the risk/return tradeoff within the housing market itself. In theory, the same positive correlation between the variation in return and the long-run average rate of return should exist among

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<sup>1</sup>Of course, risk as measured by the variation in return is not the only factor affecting the required rate of return on an investment, and some aspects of the housing market would tend to raise the expected return required to attract investors to housing rather than to stocks. Houses are considerably less liquid than stocks that trade in well-organized markets, in which large volumes of identical assets are bought and sold at frequent intervals. Moreover, there is a fundamental inability to diversify one's housing investment, especially in the case of owner-occupied housing.

geographically distinct housing markets as it does among various types of investments. Do local housing markets with a larger variation in the returns on individual houses also have higher average returns, or does the consumption/investment link negate the risk/return tradeoff within the single-family housing market?

In section 1 we show how the positive correlation between risk and return in the owner-occupied housing market follows directly from utility maximization. In section 2 we describe the data used to test whether risk and return have been positively related in local housing markets. In section 3 we report our empirical results, and we conclude in section 4.

## 1. Risk and Return in the Housing Market

When analyzing risk and return in the housing market, it is important to have a clear understanding what we mean by “risk” and “return.” Like stocks, there are two elements of the return to housing: appreciation, or capital gains, and the value of the flow of housing services, which is similar to income from stock dividends. While appreciation rates are directly observable, the value of the flow of housing services is not. In equilibrium, however, these components are linked. Housing prices at any point in time reflect the discounted value of expected future housing services. Appreciation, therefore, reflects the change from time of purchase to the time of sale in the expected value of future housing services. Since this paper is looking at equilibrium relationships between risk and return, we focus only on appreciation. Risk, in this context, is the variability in appreciation.

The relationship between risk and return is readily seen in the following example.

Consider two houses that are identical in every way. One house is in a neighborhood where there is little possibility that the characteristics of the neighborhood will change. The other house is in an identical neighborhood, except there is a 10 percent probability that a landfill will be constructed next door and a 10 percent probability that the same land will be a golf course. If we assume that the negative and positive aspects of these developments are of the same magnitude, the expected value of the two houses should be the same. But if people are risk averse, they will offer a lower price for the house for which there is uncertainty. If in the next period the uncertainty is resolved--with no development--the two houses must then have the same price, implying a higher appreciation rate for the house with the greater uncertainty.

A theoretical model demonstrating the positive relationship between risk and expected return in the owner-occupied housing market has been developed by Berkovec (1989) and employed by Gat (1994) to examine risk and return in neighborhood housing markets in Tel Aviv. We will use a variation of that model as the theoretical basis for our empirical analysis.

The model is based on the homeowner's maximization of his expected utility. Expected utility depends on expected consumption of a nonhousing composite good,  $X$ , and the consumption of housing,  $H$ , expressed in terms of quality-adjusted housing units. The homeowner's expected income consists of labor income  $Y$ , which is known for certain, and the return on his housing investment, which has an expected appreciation rate  $k_i$ , that is, the expected appreciation for neighborhood  $i$ . The variability in appreciation among houses in neighborhood  $i$  is denoted  $\sigma_i$ . This variability in appreciation introduces uncertainty in the homeowner's expected income and affects his utility negatively. The expected utility function to be maximized is

$$U(X, H, \sigma_i) \tag{1}$$

where:

$$\frac{\delta U}{\delta X} > 0$$

$$\frac{\delta U}{\delta H} > 0$$

$$\frac{\delta U}{\delta \sigma_i} < 0$$

The maximization is reduced to a one-period problem by assuming that the homeowner's wealth remains the same from one period to the next and all income from labor and the housing investment is used to service the debt on the house and consume the composite good, X. Therefore, the amount of X expected to be consumed is

$$X = Y + k_i p_i H - m p_i H \tag{2}$$

where

$k_i$  = the expected appreciation of housing in neighborhood i

$p_i$  = the price of a quality-adjusted unit of housing in neighborhood i

$m$  = the mortgage interest rate, a constant over every neighborhood and

homeowner  $0 < m < 1$

Totally differentiating (1) we obtain the following equilibrium condition

$$dU = \frac{\delta U}{\delta X}dX + \frac{\delta U}{\delta H}dH + \frac{\delta U}{\delta \sigma_i}d\sigma_i = 0 \quad (3)$$

Differentiating (2) with respect to  $k_i$  we obtain

$$dX = p_i H dk_i \quad (4)$$

Substituting (4) into (3) and keeping the amount of housing consumption constant we obtain

$$\frac{\delta U}{\delta X}(p_i H)dk_i + \frac{\delta U}{\delta \sigma_i}d\sigma_i = 0 \quad (5)$$

Rearranging

$$\frac{dk_i}{d\sigma_i} = \frac{-\frac{\delta U}{\delta \sigma_i}}{\frac{\delta U}{\delta X}(p_i H)} \quad (6)$$

As long as  $p_i$  is greater than zero, the right-hand side of equation (6) is positive and

$$\frac{dk_i}{d\sigma_i} > 0$$

that is, expected appreciation increases with the variability of appreciation in local housing markets.

## 2. Data on Risk and Return

Our basic data set comes from the 1988 and 1994 Montgomery County, Pennsylvania, appraiser's files, which have information on all properties in the county. Each observation contains information on a number of characteristics of the house, such as age and size. The file also includes the year and price of the latest sale as well as the year of the previous sale and the price at that time. Moreover, each record contains the number of the census tract, so that census-tract averages can be computed for any of the variables in the file. For our analysis we used only those houses sold after 1973 because of the small number of houses for which sale prices were available before that date.

After eliminating all non-single-family properties, all observations for which one of the sale prices or dates was not available, properties for which census tract information was missing, and any property whose price was less than \$10,000 or more than \$1,000,000, our sample included 25,627 single-family houses in 188 census tracts. Since the dates and prices for the last two sales were available, we were able to calculate the annualized real appreciation for each house over the holding period.<sup>2</sup>

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<sup>2</sup>We deflated the sale prices by the national CPI to calculate the real appreciation rate. The annualized change over the holding period was calculated as the annual log difference in the real price of the house, that is

$$\text{annual appreciation} = \left( \frac{\ln P_2 - \ln P_1}{Y_2 - Y_1} \right) \times 100 ,$$

where  $P_1$  and  $P_2$  are the market prices of the house in constant dollars at the time of the first and



We assume that each census tract represents a neighborhood that may have potentially different risks and returns for housing. Using the data on individual houses, we computed the average annual real appreciation by census tract (AVAPP) and the standard deviation of the appreciation by census tract (SDAPP). This standard deviation is the measure of neighborhood risk used in the empirical analysis. It reflects both cross-sectional variation at a point in time as well as variation of appreciation rates over time. Increased variation across either of these dimensions can increase the uncertainty about the expected appreciation rate. We should adjust, however, for any census-tract variation that does not increase the uncertainty with respect to appreciation.

Cross-sectional variation in appreciation might result from heterogeneity of the housing stock, infrequent sales, or the existence of more than one local housing market within the census tract. The first two sources of variation may increase the difficulty of estimating the true value of an individual house in the neighborhood and thus increase risk, but the presence of more than one local housing market in a census tract is likely to increase variability but not risk. This possibility raises a concern about the appropriateness of the census tract as the unit of observation. The presence of more than one definable neighborhood (one local housing market) in a census tract can raise the variation in appreciation without increasing the uncertainty about appreciation, since information could be available for each of the neighborhoods. Therefore, the size of the census tract in square miles (SIZE) was used as a proxy for the presence of more than one definable neighborhood in the tract on the assumption that larger census tracts were likely to

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second sales, respectively, and  $Y_1$  and  $Y_2$  are the years of the first and second sales.

have more than one definable neighborhood.<sup>3</sup>

One aspect of the variability of appreciation over time also raises an issue for our analysis. Some of the temporal variation in appreciation rates is driven by common factors that affect housing markets in general. Thus, the timing of sales in a census tract may affect the average appreciation for the tract. For example, if a disproportionate share of sales in some census tracts occurs in periods of high real appreciation and the variation of appreciation rates is also higher in those periods, both the average appreciation and the standard deviation for those tracts will be high. To address the concern that the timing of sales may introduce a spurious correlation between the average appreciation and the variation in appreciation, we calculated the average *excess* appreciation by census tract. Excess appreciation is defined as the difference between the actual appreciation of a house and what the appreciation would have been if the house had appreciated at the countywide average. We estimated the countywide average for each year of our sample using the repeat sales method (see the Appendix). This countywide average is a measure of market appreciation in Montgomery County, and, therefore, the difference between the actual appreciation and the countywide average is our measure of excess appreciation. We computed both the census-tract averages (AVXAPP) and standard deviations of this excess appreciation (SDXAPP). The empirical analysis presented in section 3 uses both average annual appreciation and average excess appreciation by census tract and their respective standard deviations.

We also introduced a measure of skewness into our regression analysis. The skewness of

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<sup>3</sup>The size of the census tract is positively correlated with the standard deviation of appreciation (correlation coefficient = 0.15, statistically significant at the 5 percent level).

the distribution of appreciation or of excess appreciation by census tract (SKAPP and SKXAPP) was used to control for the possible effect of outliers in the data. In particular, some houses may have very large appreciation rates that are due to major unobserved housing improvements. These observations would increase both the mean and standard deviation of the tract, introducing a spurious correlation between our measured risk and return variables.

**Table 1**

**MEANS, VARIANCES, MAXIMUM AND MINIMUM OF CENSUS-TRACT VARIABLES**

<b>Variable</b>	<b>Mean</b>	<b>Variance</b>	<b>Maximum</b>	<b>Minimum</b>
AVAPP	3.19	2.07	9.65	- 0.57
AVXAPP	0.51	1.42	5.21	- 2.27
SDAPP	7.56	3.53	16.99	3.38
SDXAPP	6.18	3.98	15.21	1.88
SKAPP	0.20	1.99	3.34	- 4.05
SKXAPP	0.10	5.53	5.39	- 8.75
SIZE	2.41	11.12	21.56	0.13

Table 1 presents the means, variances, maximum and minimum of the census tract averages for our variables. Figure 1 displays the distribution of appreciation across census tracts by quartile. Similarly, Figure 2 shows the standard deviation of appreciation across census tracts

by quartile. The main conclusion one should draw from these maps is that areas of higher appreciation occur throughout the county. Also, there is little obvious geographic pattern to the standard deviation of appreciation. Figures 3 and 4 show the same information for excess appreciation and its standard deviation. Since there is no geographic pattern in these variables, it is unlikely that the econometric results presented in the following section reflect spatially correlated omitted variables rather than the underlying risk/return relationship.

### 3. Empirical Model and Results

Our model assumes that decisions on housing investments are based on expected appreciation and that expected appreciation differs by neighborhood. We assume that, on average, expected appreciation in a local market (neighborhood) is realized and that the uncertainty associated with the expectation can be proxied by the variability in appreciation within the neighborhood. Therefore, our empirical analysis relies on realized appreciation and the standard deviation of appreciation among houses within the local market. We also control for factors that could affect the variability in appreciation within the census tract but that are not related to uncertainty about appreciation.

The basic equation to be estimated using average real appreciation was

$$AVAPP = \alpha + \beta_1 SDAPP + \beta_2 SKEW + \beta_3 SIZE \quad (7)$$

where

AVAPP = The average by census tract of the annualized real appreciation

SDAPP = The standard deviation of the annualized real appreciation by census tract

SKEW = The skewness in the annualized real appreciation rate by census tract

SIZE = The size of the census tract in square miles.

The estimated coefficients from this equation are presented in Table 2.

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**TABLE 2**

**REGRESSION RESULTS FROM EQUATION FOR AVERAGE REAL APPRECIATION**

<b>Variable</b>	<b>Estimated Coefficient</b>	<b>Standard Error</b>
Constant	0.3562	0.3654
SDAPP	0.3850*	0.0470
SKEW	0.4753*	0.0620
SIZE	-0.0719*	0.0257

Adjusted R<sup>2</sup> = 0.35 N = 188

\*Significant at the .01 percent level

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As predicted by our theoretical model, the standard deviation of house price appreciation within a census tract (SDAPP) is positively related to the average appreciation in the census tract (AVAPP). The estimated coefficient (0.385) is highly significant. We can calculate the economic significance of the estimate by comparing the predicted difference between the average appreciation for the census tract with the highest standard deviation (16.99) and the tract with the

lowest standard deviation (3.38). Controlling for skewness and the size of the census tract, the difference in the estimated average of real appreciation between these two tracts is approximately 5.2 percent. While this difference may seem large, it does represent the extreme case. If we consider the difference between a census tract in which the variability in appreciation (standard deviation of appreciation) is two standard deviations above the average of the 188 census tracts in our sample and one whose variability is two standard deviations below the average, the difference in estimated average annual appreciation is approximately 2.9 percent.

The estimated coefficients on our two control variables (SKAPP and SIZE) were also statistically significant. The estimated coefficient on the skewness variable was positive as expected. The size of the census tract has a negative coefficient, indicating that larger tracts are associated with lower average appreciation. The negative coefficient may be due to the fact that larger tracts have more developable land and therefore fewer supply constraints that would raise prices in the face of increased demand.

We also estimated the model specified in equation (7) using our measure of excess appreciation (AVXAPP) and the standard deviation of excess appreciation (SDXAPP). As shown in Figure 5, the Montgomery County housing market in the past 24 years has been characterized by cycles of high and low real appreciation. Since our data span several housing cycles, it is possible that some census tracts could have a disproportionately high percentage of sales in high appreciation periods relative to the percentage for other tracts. Thus, their average appreciation rates over the entire sample period would be high. If periods of high appreciation are accompanied by a large variation in appreciation rates, a positive correlation between high appreciation rates and the variation in appreciation could be spurious. Our measure of excess

appreciation would avoid this possible spurious link. The results from this second regression equation are shown in Table 3. They are virtually identical to those presented in Table 2. Risk, as measured by the standard deviation of excess appreciation, is positively rewarded by higher average excess appreciation.

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**TABLE 3**  
**REGRESSION RESULTS FROM EQUATION FOR AVERAGE EXCESS APPRECIATION**

<b>Variable</b>	<b>Estimated Coefficient</b>	<b>Standard Error</b>
Constant	1.1220*	0.2889
SDXAPP	0.3607*	0.0452
SKXAPP	0.2862*	0.0377
SIZE	-0.0793*	0.0261

Adjusted R<sup>2</sup> = 0.34 N = 188

\*Significant at the .01 percent level.

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## 4. Conclusion and Suggestions for Future Research

Using a large data set of suburban repeat sales transactions over a 22-year period, we examined the relationship between appreciation rates at the census tract level and the risk or uncertainty of that return, as measured by tract level standard deviations in appreciation. We found a statistically and economically significant relationship of the expected sign; that is, increased risk yields an increased return.

The research suggests the need for additional investigation into the characteristics of tract level risk. In particular, is the cross-sectional component or the temporal component of the risk more important? That is, is it the variation in the appreciation rates within tracts that drives the premia, or is it the differences in variance over time of appreciation across tracts? The research also points to the need to investigate the underlying determinants of risk and why risks may be different across census tracts. Are the risks associated with informational problems associated with thin markets? Do the risks differ depending on the elasticity of supply of housing? Do risks reflect differential relationships across suburban communities with central cities, which may have greater variation in economic performance? Our results show a strong relationship between housing market risk and return, but the underlying determinants of the risk differentials are not yet well understood.



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## Appendix

The annual appreciation for Montgomery County was estimated by the repeat sales method described in Crone and Voith (1992). All 25,627 repeat-sale observations in the county were used to estimate the following equation

$$\ln\left(\frac{P_2}{P_1}\right) = \sum_{h=1}^n \delta_h D_h + \varepsilon \quad (A1)$$

where

$P_1$  = the initial sale price in constant dollars

$P_2$  = the second sale price in constant dollars

$D_h$  = a year dummy for years 1 to n in our sample.

The estimated coefficient  $\delta_h$  will equal the difference between  $\ln P_h$  and  $\ln P_{h-1}$  for the average house in Montgomery County. The regression results are shown in Table A1.

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**TABLE A1****REGRESSION RESULTS FROM EQUATION (A1 )**

<b>Variable</b>	<b>Estimated Coefficient</b>	<b>Standard Error</b>
D71	0.0066	0.0309
D72	0.0204	0.0162
D73	0.0688*	0.0089
D74	0.0158**	0.0088
D75	-0.0355*	0.0088
D76	0.0261*	0.0080
D77	0.0013	0.0071
D78	0.0133*	0.0066
D79	-0.0209*	0.0064
D80	-0.0567*	0.0070
D81	-0.0512*	0.0078
D82	-0.0557*	0.0081
D83	0.0478*	0.0074
D84	0.0404*	0.0063
D85	0.0610*	0.0060
D86	0.1412*	0.0055
D87	0.1374*	0.0054
D88	0.1091*	0.0057
D89	0.0257*	0.0065
D90	-0.0485*	0.0074
D91	-0.0535*	0.0077
D92	-0.0092	0.0075
D93	-0.0316*	0.0073
D94	0.0303**	0.0169

Adjusted R<sup>2</sup>=0.51 N=25627

\*Denotes significance at the 95% level

\*\*Denotes significance at the 90% level

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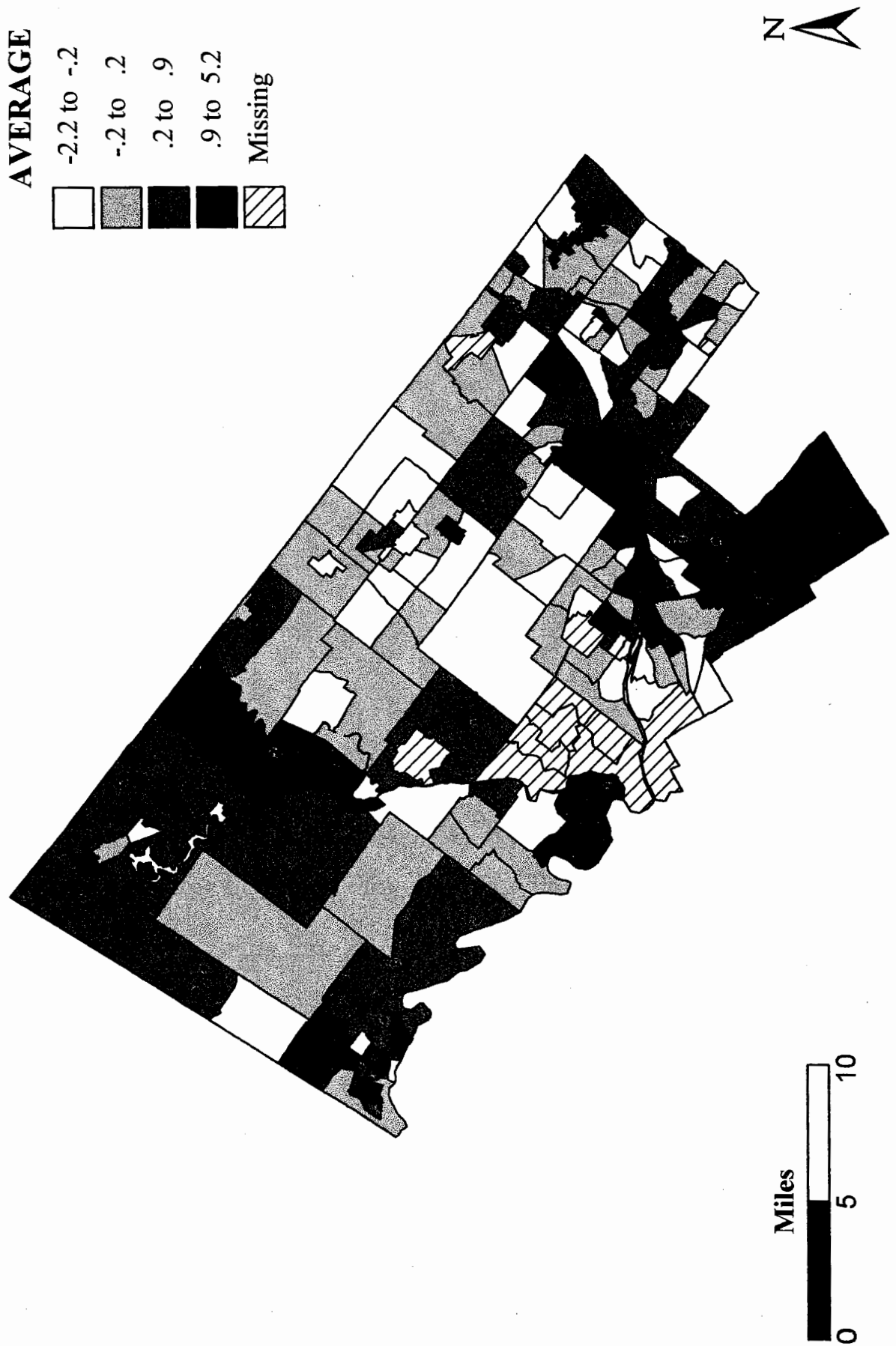
**Figure 1**  
**Average Appreciation by Census Tract**



**Figure 2**  
**Standard Deviation of Appreciation by Census Tract**



**Figure 3**  
**Excess Appreciation by Census Tract**



**Figure 4**  
**Standard Deviation of Excess Appreciation by Census Tract**



Figure 5  
 Countywide Annual Appreciation Rates

