Supply & Demand Determinants of Home-Price Sensitivity to Capital Market Factors*

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Abstract: Finance theory suggests that personal wealth invested in a home should affect other household financial decisions such as portfolio allocations among financial investments. However, little empirical work exists to suggest how homeowners might evaluate their home's exposure to capital market risk factors in order to incorporate such information into their broader investment decision making. In this paper we investigate how home-price sensitivity to equity market risk factors varies across more than two thousand ZIP Codes in 74 US cities. Our investigation suggests that a homeowner's exposure to capital market risk factors varies by city-specific supply and demand factors, especially for ZIP Codes with higher priced homes whose residents are most likely stock market participants and corporate executives. Our results are twofold. First, we segment ZIP Codes by the city-specific measure of housing supply constraints and supply elasticity as developed by Saiz (2010). Among above-median priced zip codes we find that home-price sensitivity to equity market risk increases with city-specific supply constraints. Second, recent research in finance documents that equity incentives in managerial compensation vary across US cities due to agglomeration patterns in corporate headquarters decisions and social network effects in executive compensation schemes among same-city firms. We measure the level of equity-based pay incentives for CEOs and other top executives among firms that share headquarters cities. Consistent with a conjecture by Cannon, Miller, and Pandher (2006), among above-median priced ZIP Codes home-price sensitivity to equity market risk increases in MSA-level incentives for managerial risk-taking.

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1. Introduction

In the United States more than 60% of households own their residences, most with mortgaged and therefore leveraged investments in home equity. Households also make critical financial decisions involving both financial market investments and real estate investments, and must allocate resources among stock or bond portfolios conditional on what for many households is a large and leveraged exposure to home price risk. Economic theory suggests that returns to assets in capital markets and real estate markets are integrated (e.g., Quan and Titman, 1999), and many studies – largely theoretical – investigate how home-related wealth might condition investment decisions by households (Flavin and Yamashita, 2002; Benjamin, Chinloy, and Jud, 2004; Cocco, 2004; Piazzesi, Schneider, and Tuzel, 2005; Yao and Zhang, 2005; Qi and Wu, 2006). The theoretical models in such studies typically assume that homeowners acknowledge how home price appreciation depends on future shocks to their income and changes in personal wealth due to returns on portfolios of financial securities.

Because of dispersion of such sensitivities across geography and home-specific characteristics, information on central tendencies across all homes or even homes within a state or city may not be sufficiently useful to homeowners, as sub-market trends are often not captured by trends for wider geographic areas, but there are few studies that examine geography-specific measures of home price risk and how it is associated with financial market risk factors (Goetzmann and Spiegel, 1997; Jud and Winkler, 2002; Cannon, Miller, and Pandher, 2006). For example, Anderson and Beracha (2010) find that home price sensitivity to capital market risk factors increases with Zip Code-specific median home values, consistent with the notion that demand for higher priced homes is more likely to come from more affluent households with more personal wealth exposed to capital market risks.

In this paper, we extend prior studies by further investigating how capital market pricing sensitivities of home-price returns are influenced by aspects of economic and social geography. We measure home price sensitivity to equity market risk using quarterly ZIP Code level data on median home prices across several thousand US ZIP Codes and 74 US metropolitan statistical areas. We then investigate how city-specific factors that affect supply and demand for housing condition our estimates for home-price exposure to equity market risk, especially among higher priced ZIP codes most likely to be populated by stock market participants and managerial employees whose personal wealth is more likely affected by stock market movements.

First, we hypothesize that geographic and regulatory constraints on new housing supply are likely to augment home-price sensitivity to stock market movements, especially among higher priced homes most likely to be owned by affluent households with extant exposure to stock market risk. The basic idea is that when such households experience a shock to their personal wealth due to stock market movements their demand for housing will increase. Home price changes in response the wealth-related demand shock will depend on supply constraints and price-elasticity of supply. Our empirical results support this hypothesis. Specifically, among above-median priced zip codes we find that home-price sensitivity to equity market risk increases with city-specific supply constraints as measured by Saiz (2010).

Second, we hypothesize home price sensitivity to equity market movements increases when the incomes and personal wealth of affluent homeowners are more closely tied to equity market risks. Our hypothesis is motivated quite explicitly by a conjecture in Cannon, Miller, and Pandher (2006):

> "Houses in zip codes that are more sensitive to the stock market, presumably in wealthier neighborhoods, have the potential of greater price appreciation when the stock market is doing well. When the stock market is rising, some households in these stock-sensitive markets have more income and wealth due to the positive impact of the market on professional and managerial compensation (e.g., bonuses,

> equity and stock options). Some of this wealth may be transferred into housing . . ." (p. 550).

Specifically, we examine equity incentives for corporate executives employed by firms headquartered across our sample cities. Corporate executives in large firms are well paid – often in the form of equity-based pay such as stock and option awards, have much higher-than-average levels of personal wealth, and have more of their wealth exposed to firm-specific and market-wide performance. They also move in social circles with other local elites, especially with respect to congregating in neighborhoods characterized by high priced homes (e.g., Ang, Nagel, and Yang, 2012). We measure managerial incentives using annual CEO compensation data in S&P 1500 firms associated with 116 metropolitan statistical areas (MSAs) from 1994 to 2000. Our empirical results support our hypotheses. In ZIP Codes with high-priced homes we find that home price sensitivity to capital market factors is positively associated with the risk-taking managerial incentives for firms headquartered in that city. This finding is consistent with the notion that residents of high-priced ZIP Codes are influenced more by local risk-taking cultures as manifest among corporate executives in their city, and they exhibit higher levels of integration of capital market investments and real estate investments.

2. Data and Methods

2.1. Home-Price Data for U.S. ZIP Codes

We use quarterly median sales prices for single-family homes by U.S. Zip Code. We purchased the home price database from American Real Estate Solutions. The initial sample include 3,309 ZIP Codes for which median sales prices for single-family homes are observed from the fourth quarter of 2000 to the fourth quarter of 2006. The intersection of the home price database and the executive compensation data leaves us the final sample of 2560 ZIP Codes with consecutive quarterly home price observations from 2001 to 2006.[1] Table 1 shows summary statistics about sample ZIP Codes.

2.2. Estimating Capital Market Pricing Sensitivities

Following Anderson and Beracha (2010), we estimate home price sensitivity to capital market risk factors by the following equation:[2]

$$R_{ZIP,t} - R_{F,t} = \alpha_{ZIP} + \phi_{ZIP}^{-1}(R_{ZIP,t-1} - R_{F,t-1}) + \phi_{ZIP}^{-2}(R_{ZIP,t-2} - R_{F,t-2})$$

$$+ \beta_{ZIP}^{0}(R_{M,t} - R_{F,t}) + \beta_{ZIP}^{-1}(R_{M,t-1} - R_{F,t-1}) + \beta_{ZIP}^{-2}(R_{M,t-2} - R_{F,t-2})$$

$$+ \tau_{ZIP}^{0}(R_{B,t} - R_{F,t}) + \tau_{ZIP}^{-1}(R_{B,t-1} - R_{F,t-1}) + \tau_{ZIP}^{-2}(R_{B,t-2} - R_{F,t-2}) + \varepsilon_{ZIP,t} \quad (1)$$

In Equation (1), $R_{ZIP,t}$ is quarterly percent change in median home prices at a ZIP Code. $R_{F,t}$ is the quarterly risk-free rate. $R_{M,t}$ is the quarterly return on the CRSP value-weighted equity portfolio. $R_{B,t}$ is the quarterly return on 10-year U.S. Treasury notes. Similar to prior studies (e.g. Cannon, Miller, and Pandher, 2006; Anderson and Beracha, 2010), we estimate versions of Equation (1) independently for each ZIP Code in our sample. Then we compute factor sensitivities as the current and lagged estimated factor loadings as in Equation (2) and (3).

$$\hat{\beta}_{ZIP} = \hat{\beta}_{ZIP}^{0} + \hat{\beta}_{ZIP}^{-1} + \hat{\beta}_{ZIP}^{-2} \quad (2)$$

$$\hat{\tau}_{ZIP} = \hat{\tau}_{ZIP}^{0} + \hat{\tau}_{ZIP}^{-1} + \hat{\tau}_{ZIP}^{-2} \quad (3)$$

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[1] Descriptive information on this sample of ZIP Codes is provided in Anderson and Beracha (2010).
[2] Please refer to Anderson and Beracha (2010) for an extensive motivation for these methods.

Table 2 reports the mean values for betas after sorting the sample of ZIP Codes by median home price. In Table 2, in each quintile of ZIP Codes sorted by median home prices, beta estimates, the home price sensitivity to equity market factors, are significantly positive in the range from 0.092 to 0.248. The spread of beta between High home price group and Low home price group is 0.156, and it is significant with a t-statistics of 2.46. This result reproduces the finding in Anderson and Beracha (2010) that the mean values of equity market sensitivity in ZIP Codes with higher priced homes are significantly higher than those in ZIP Codes with lower priced homes. The findings support the notion that residents in high-price ZIP Codes are likely to participate more in equity market and hence expose more to equity market risks.

2.3. Housing Supply Constraints

Saiz (2010) develops supply elasticity measures by using geographical and regulatory constraints to housing supply. He uses satellite-based geographic data to precisely estimate exogenously undevelopable land in cities, which reflects geographic restrictions. Regulatory constraints are measured by using the Wharton Residential Urban Land Regulation Index created by Gyourko, Saiz, and Summers (2008), which captures the local regulatory restrictions of housing supply. The measure of housing supply elasticity of Saiz (2010) varies at the Metropolitan Statistical Area (MSA) level. MSAs where it is difficult to supply new housing due to geographic or regulatory constraints are measured as low elasticity, while areas where housing supply is easily available are classified as high elasticity. This measure is available for 95 MSAs in Saiz (2010), and our final sample has elasticity measure for 74 MSAs after matching with housing price data and executive compensation data. Table 3 represents the summary of housing supply elasticity measure used in our sample. In MSAs such as Miami, cities in California, New York, Chicago, and Boston, where available land is largely constrained, supply elasticities are smaller than one. MSAs in the Midwest and the South such as San Antonio, Austin, and Kansas City are highly elastic in housing supply.

2.4. Executive Compensation Data for S&P 1500 firms

The relation between executive compensation, business policies, and firm risk is extensively studied in corporate finance literature. In recent years firms extensively use equity-based awards, in the form of stock and options, in executive compensation (Murphy 1999; Perry and Zenner 2000). Subsequently, CEOs' wealth has been substantially more sensitive to stock price (Hall and Liebman 1998). Delta and vega are two important measures used to capture the essence of managerial contracts that incentivize managers to increase firm value and take risks (Core and Guay 2002). Delta is the change in the dollar value of the CEO's stock and option portfolio for a 1% change in stock price. Vega is the change in the dollar value of the CEO's stock and option portfolio for a 0.01 change in stock return volatility. Guay (1999) finds that stock return volatility is associated contemporaneously with vega. Rajgopal and Shevlin (2002) show that oil exploration risk is positively correlated with lagged vega. Knopf et al. (2002) find that firm policies on derivatives are negatively related to vega. Cohen et al. (2000) show that leverage is positively correlated with CEO vega. Coles, Daniel, and Naveen (2006) find that higher vega is associated with riskier firm policies, such as higher R&D, less investment in PPE, more focus, and higher leverage. These studies provide evidence that high-vega incentives encourage managerial risk-taking behaviors. Smith and Stulz (1985) present that poorly diversified executives with high delta may become risk averse and predict that risk-taking is negatively related to delta. Other studies find that CEO delta is negatively associated with leverage and firms' hedging activities (Coles, Daniel, and Naveen 2006, Knopf and Thornton 2002). In sum, prior studies show that managerial incentives affect policy choices and subsequently change firm risk.

We estimate the CEO compensation variables (delta, vega) using data from the Execucomp, which contains data on executive pay from proxy statements of large publicly traded U.S. firms. Vega measures the CEO's pay-for-risk sensitivity, which is how the CEO's wealth portfolio changes with an increase in the firm's stock return volatility. Delta measures the CEO's pay-for-performance sensitivity, which is how the CEO's wealth portfolio changes with an increase in the firm's stock price. We compute delta and vega by following the methodology proposed by Guay (1999) and Core and Guay (2002), which uses the Black-Scholes (1973) option valuation model modified by Merton (1973) to account for dividends. Both delta and vega are expressed in terms of thousand dollars of 2004 adjusted for inflation.

We estimate annual CEO delta and vega for the S&P 1500 firms from 1994 to 2000. Firms that are headquartered in the same MSA are assigned into a group. Within each MSA group of firms, the median of the pooled CEO vega is classified as MSA vega, while the median of the pooled CEO delta is classified as MSA delta. MSA delta and vega vary at the MSA level and reflect cross-sectional variations of risk-taking culture during 1994-2000. Table 4 represents the summary statistics of CEO delta and vega, and MSA delta and vega. In the final sample, we have 1735 firms, 6617 firm-year observations of CEO delta and vega, and the aggregated 74 MSA delta and vega. The mean of CEO delta shows that the average CEO wealth portfolio increases by 1,727,000 dollars with 1% increase in the firm's stock price. The mean of CEO vega shows that the average CEO wealth portfolio increases by 65,000 dollars with a 0.01 increase in the firm's stock return volatility. Note that distributions of both CEO delta and vega are highly rightward skewed, where the means are much larger than the medians. MSA delta is the median of the pooled CEO delta in firms that are headquartered in the same MSA. MSA vega is the median of the pooled CEO vega in firms that are headquartered in the same MSA. Not surprisingly, the impact of right-tail outliers on distributions is much mitigated when delta and vega are aggregated at the MSA level. To further reduce outlier effect, we follow the literature and apply the natural log transformation to both MSA delta and vega prior to regression estimation.

3. Results

3.1. Housing Supply Constraints and Home-Price Sensitivity to Equity Risk

Figure 1 shows how Saiz's (2010) measure of housing supply elasticity conditions the relation between median home prices and home price betas. In panel A of Figure 1 we compare our measures of housing betas for sample ZIP Codes by means of a 2x2 sort into above median and below median subsamples by both housing supply elasticity and median home price. In panel B we sort more finely into a 5x5 sort into quintiles. Consistent with our hypothesis, both figures show that our estimates of home price sensitivity to equity market risk are decreasing in housing supply elasticity among higher priced ZIP Codes. In other words, homes in higher priced ZIP Codes in cities with more supply constraints have greater equity market risk than homes in higher priced ZIP Codes in cities with fewer supply constraints.

Table 5 and Table 6 investigate our hypothesis on the relation between supply elasticity and home-price sensitivity to equity market risk in multivariate analysis that includes an assortment of ZIP code-specific and MSA-specific variables. These latter variables include population, per capita income, per capita investment income, state-tax rate for capital gains, and regional indicator variables (the Midwest region is the base case). In Table 5 we sort ZIP Codes conditionally *within each MSA* by median home price, hence when we refer to ZIP Codes by upper 50% of home prices or upper 25% of home prices we mean relative to other ZIP Codes within the same city. In other words, those samples contain the higher priced ZIP Codes for each MSA in our sample. In Table 6 we sort ZIP Codes unconditionally across all US cities. In this sorting the higher priced subsamples will include absolutely higher priced ZIP Codes from across all cities, which will over-sample from higher priced cities and exclude some relatively highly priced ZIP Codes within some of the more affordable US cities.

In both Table 5 and Table 6 we observe that the relation between home price levels and our measures of housing betas is conditioned by supply elasticity. Column (1) confirms the basic inference of Anderson and Beracha (2010) that the housing betas are increasing in home price. However, when we concentrate on higher priced ZIP Codes – those most likely to be populated by equity market participants – we find a consistently negative relation between Saiz's (2010) measure of housing supply elasticity and home price sensitivity to equity market movements. In Table 5, in which the subsamples (upper 50%, upper 25%) are the highest priced homes within each city, the relation between home price levels and equity market attenuates while the coefficients on supplly elasticity are consistently negative and significant. Furthermore, in Table 5 the coefficient for the upper quartile of ZIP Codes by home price sort within each city is consistently about double that for the sample based on an upper 50% sort. Overall, these results are consistent with our hypothesis that the presence of supply constraints is an important city-specific variable that affects the relationship between home price movements and equity market movements, especially among higher priced homes most likely to be owned by stock market participants.

3.2. Managerial Equity Incentives and Home-Price Sensitivity to Equity Risk

Table 7 investigates our hypothesis on the relation between managerial equity incentives and home-price sensitivity to equity market risk in multivariate analysis that includes both supply elasticity and an assortment of other ZIP code-specific and MSA-specific variables. The results suggest that when supply elasticity is low the home price sensitivity to equity market factors is higher when local risk-taking culture – as measured by vega -- is strongly positive. Specifically, in columns (2) and (3) of Table 7 – which exclude the upper 50% and upper 75% of MSAs based on supply elasticity – we find that there is a strongly positive relation between the city-specific measure of median vega and our estimate of home price sensitivity to equity market risk. Again, vega measures the sensitivity of a manager's wealth to his company's stock price volatility, and is often posited as a measure of incentives for risk-taking at the corporate level. Our results suggest that in cities with corporate executives who have greater risk-taking incentives home prices are more sensitivity to overall stock market movements.

Conclusions

We investigate how home-price sensitivity to equity market risk factors varies across more than two thousand ZIP Codes in 74 US cities. Our investigation suggests that a homeowner's exposure to capital market risk factors varies by city-specific supply and demand factors, especially for ZIP Codes with higher priced homes whose residents are most likely stock market participants and corporate executives. We first segment ZIP Codes by the city-specific measure of housing supply constraints and supply elasticity as developed by Saiz (2010). Among above-median priced zip codes we find that home-price sensitivity to equity market risk increases with city-specific supply constraints. Second, we measure the level of equity-based pay incentives for CEOs and other top executives among firms that share headquarters cities. Consistent with a conjecture by Cannon, Miller, and Pandher (2006), among above-median priced ZIP Codes and in cities with lower levels of housing supply elasticity we find that home-price sensitivity to equity market risk increases in MSA-level equity incentives for managerial risk-taking. Recent research in finance documents that equity incentives in managerial compensation vary across US cities due to agglomeration patterns in corporate headquarters decisions and social network effects in executive compensation schemes among same-city firms. Our latter result suggests that these geographic patterns in managerial incentives have spiller effects in residential real estate markets.

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Table 1
Summary Statistics for ZIP Code data

Number of ZIP Codes	2560
Number of MSAs	116
Average ZIP Codes per MSA	22.07
Median ZIP Codes per MSA	14.5
Minimum number of Zip Codes per MSA	1
Maximum number of ZIP Codes per MSA	135

Table 2
Home Price Sensitivity in ZIP Codes Sorted by Median Home Prices

	Low	2	3	4	High	H - L
Beta	0.092	0.169	0.224	0.199	0.248	0.156
(t-stat)	(1.65)	(6.22)	(8.99)	(7.10)	(8.04)	(2.46)

Table 3
Housing supply elasticity as per Saiz (2010) for 74 sample MSAs

Rank	MSA	Supply elasticity	Rank	MSA	Supply elasticity
1	Miami-Fort Lauderdale-West Palm Beach, FL	0.60	26	Las Vegas-Henderson-Paradise, NV	1.39
2	San Francisco-Oakland-Hayward, CA	0.66	27	Rochester, NY	1.40
3	San Diego-Carlsbad, CA	0.67	28	Tucson, AZ	1.42
4	Oxnard-Thousand Oaks-Ventura, CA	0.75	29	Minneapolis-St. Paul-Bloomington, MN-WI	1.45
5	Salt Lake City, UT	0.75	30	Hartford-West Hartford-East Hartford, CT	1.50
6	San Jose-Sunnyvale-Santa Clara, CA	0.76	31	Springfield, MA	1.52
7	New York-Newark-Jersey City, NY-NJ-PA	0.76	32	Denver-Aurora-Lakewood, CO	1.53
8	Chicago-Naperville-Elgin, IL-IN-WI	0.81	33	Washington-Arlington, DC-VA-MD-WV	1.61
9	Virginia Beach-Norfolk-Newport News, VA-NC	0.82	34	Providence-Warwick, RI-MA	1.61
10	Boston-Cambridge-Newton, MA-NH	0.86	35	Phoenix-Mesa-Scottsdale, AZ	1.61
11	Worcester, MA-CT	0.86	36	Harrisburg-Carlisle, PA	1.63
12	Seattle-Tacoma-Bellevue, WA	0.88	37	Bakersfield, CA	1.64
13	Riverside-San Bernardino-Ontario, CA	0.94	38	Philadelphia-Camden-Wilmington, PA-NJ-DE-MD	1.65
14	Bridgeport-Stamford-Norwalk, CT	0.98	39	Albany-Schenectady-Troy, NY	1.70
15	New Haven-Milford, CT	0.98	40	Memphis, TN-MS-AR	1.76
16	Tampa-St. Petersburg-Clearwater, FL	1.00	41	Buffalo-Cheektowaga-Niagara Falls, NY	1.83
17	Cleveland-Elyria, OH	1.02	42	Fresno, CA	1.84
18	Milwaukee-Waukesha-West Allis, WI	1.03	43	Allentown-Bethlehem-Easton, PA-NJ	1.86
19	Jacksonville, FL	1.06	44	Stockton-Lodi, CA	2.07
20	Portland-Vancouver-Hillsboro, OR-WA	1.07	45	Albuquerque, NM	2.11
21	Orlando-Kissimmee-Sanford, FL	1.12	46	Raleigh, NC	2.11
22	Vallejo-Fairfield, CA	1.14	47	Durham-Chapel Hill, NC	2.11
23	Napa, CA	1.14	48	Birmingham-Hoover, AL	2.14
24	Baltimore-Columbia-Towson, MD	1.23	49	Dallas-Fort Worth-Arlington, TX	2.18
25	Detroit-Warren-Dearborn, MI	1.24	50	Toledo, OH	2.21

Table 3 (Continued)

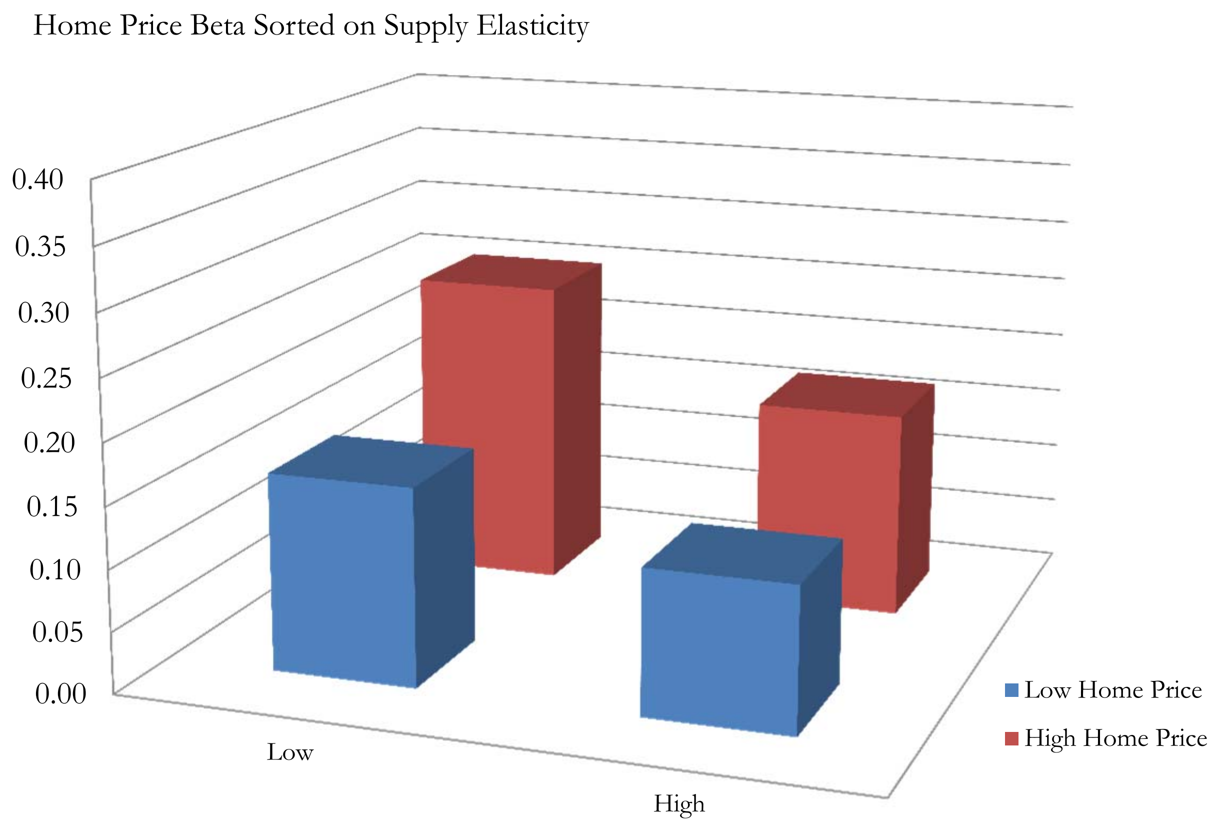
Rank	MSA	Supply elasticity	Rank	MSA	Supply elasticity
51	Nashville-Davidson-Murfreesboro--Franklin, TN	2.24	63	Greenville-Anderson-Mauldin, SC	2.71
52	Ann Arbor, MI	2.29	64	Little Rock-North Little Rock-Conway, AR	2.79
53	Houston-The Woodlands-Sugar Land, TX	2.30	65	San Antonio-New Braunfels, TX	2.98
54	El Paso, TX	2.35	66	Austin-Round Rock, TX	3.00
55	St. Louis, MO-IL	2.36	67	Charlotte-Concord-Gastonia, NC-SC	3.09
56	Cincinnati, OH-KY-IN	2.46	68	Greensboro-High Point, NC	3.10
57	Atlanta-Sandy Springs-Roswell, GA	2.55	69	Winston-Salem, NC	3.10
58	Akron, OH	2.59	70	Kansas City, MO-KS	3.19
59	Richmond, VA	2.60	71	Oklahoma City, OK	3.29
60	Youngstown-Warren-Boardman, OH-PA	2.63	72	Tulsa, OK	3.35
61	Columbia, SC	2.64	73	Dayton, OH	3.71
62	Columbus, OH	2.71	74	Indianapolis-Carmel-Anderson, IN	4.00

Table 4
Summary statistics for executive compensation variables

	N	Mean	Std. Dev.	25th %	Median	75th %
CEO delta ($thousands)	6617	1,727	17,097	73	215	653
CEO vega ($thousands)	6617	65	151	6	23	66
MSA delta ($thousands)	74	219	164	98	197	274
MSA vega ($thousands)	74	21	11	14	19	27
ln(MSA delta)	74	5.04	1.06	4.58	5.29	5.61
ln(MSA vega)	74	2.72	1.37	2.63	2.95	3.30

Figure 1. Home Price Beta Sorted on Home Price and Supply Elasticity

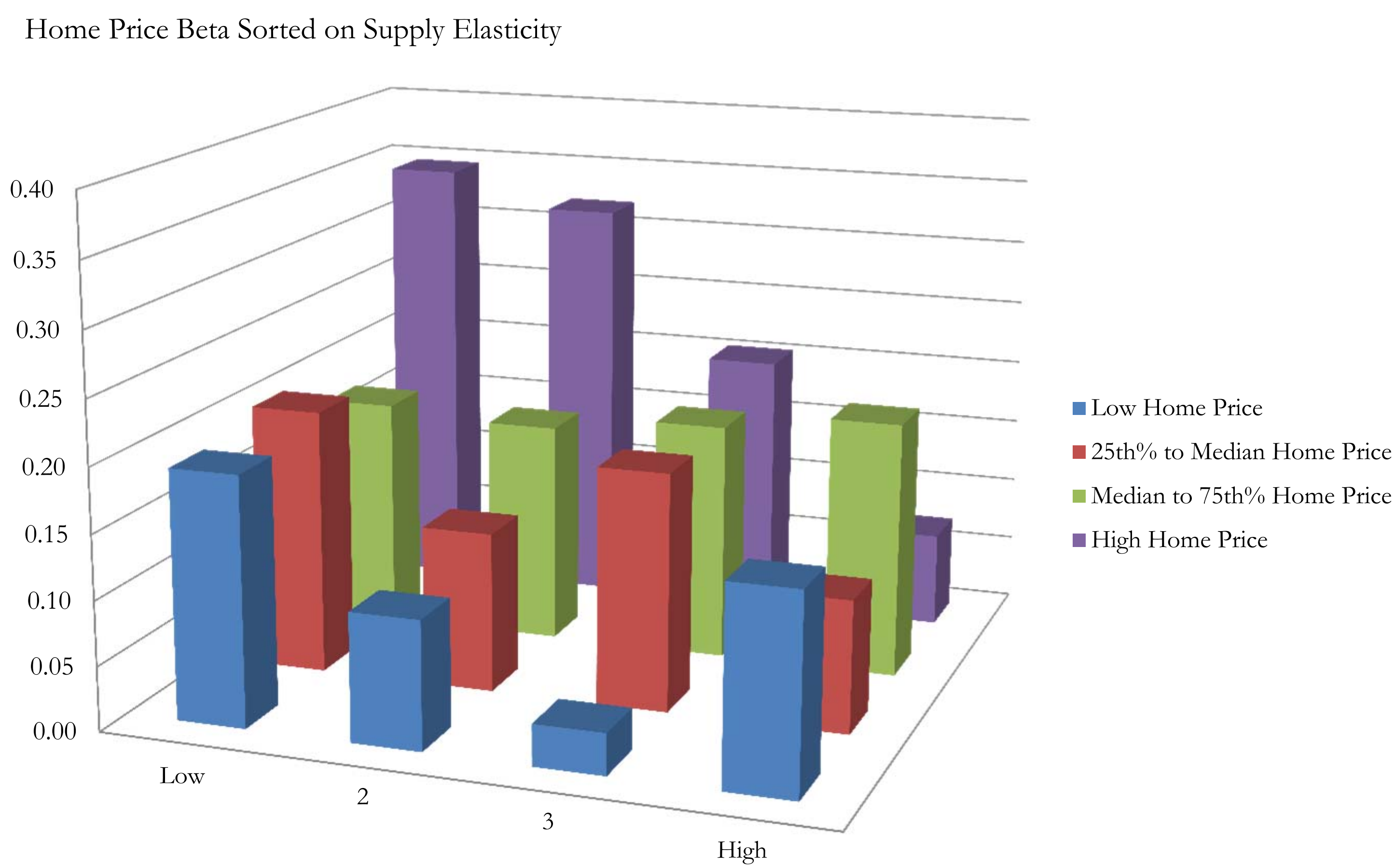
Panel A. 2 by 2 sorting



High Home Price: Beta Spread by (Low Supply Elasticity – High Supply Elasticity)

0.0844, p-value = 0.0434

Panel B. 4 by 4 sorting



High Home Price: Beta Spread by (Low Supply Elasticity – High Supply Elasticity)

0.2734, p-value = 0.0122

Table 5 – Regression Results on Supply Elasticity; Conditional sorting

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent variables	Beta	Beta	Beta	Beta	Beta	Beta	Beta
Sample range	Full sample	By MSA: Zip-code median home price >=Median	By MSA: Zip-code median home price >=75th %	By MSA: Zip-code median home price >=Median	By MSA: Zip-code median home price >=75th %	By MSA: Zip-code median home price >=50th %	By MSA: Zip-code median home price >=75th %
ln(Median home price)	0.0839**	0.0364	-0.00631	0.0143	-0.00348	0.0418	-0.0177
	(2.073)	(0.777)	(-0.0719)	(0.250)	(-0.0313)	(0.630)	(-0.132)
Supply elasticity	-0.0220	-0.0532**	-0.128***	-0.0715**	-0.144***	-0.0620**	-0.148***
	(-1.057)	(-2.156)	(-2.951)	(-2.384)	(-2.677)	(-1.973)	(-2.616)
ln(Population)				-0.0461*	-0.0920**	-0.0307	-0.0974**
				(-1.647)	(-2.070)	(-1.016)	(-2.027)
ln(Per capita personal income)						-0.311	0.129
						(-1.394)	(0.314)
ln(Per capita personal investment income)				0.0652	0.153	0.172	0.111
				(0.736)	(1.000)	(1.562)	(0.591)
Max. state tax rate for long term capital gain				0.0161***	0.0135	0.0176***	0.0129
				(2.709)	(1.456)	(3.044)	(1.453)
Northeast region				-0.00114	0.0845	0.0128	0.0787
				(-0.0128)	(0.577)	(0.143)	(0.524)
South region				0.0986	0.114	0.0901	0.119
				(1.489)	(0.944)	(1.351)	(0.976)
West region				0.0602	0.0311	0.0504	0.0357
				(0.779)	(0.223)	(0.649)	(0.256)
Constant	-0.772	-0.134	0.548	0.136	0.406	1.892	-0.325
	(-1.557)	(-0.232)	(0.494)	(0.158)	(0.287)	(1.352)	(-0.132)
Observations	2,226	1,137	551	1,137	551	1,137	551
Number of MSAs	74	74	72	74	72	74	72
Adjusted R-squared	0.005	0.005	0.014	0.010	0.016	0.010	0.014

Table 6 – Regression Results on Supply Elasticity; Unconditional sorting

Dependent variables	(1) Beta	(2) Beta	(3) Beta	(4) Beta	(5) Beta	(6) Beta	(7) Beta
Sample range	Full sample	Zip-code median home price >=Median	Zip-code median home price >=75th %	Zip-code median home price >=Median	Zip-code median home price >=75th %	Zip-code median home price >=50th %	Zip-code median home price >=75th %
ln(Median home price)	0.0839**	0.0822	0.241***	0.0836	0.228**	0.109	0.247**
	(2.073)	(1.469)	(2.627)	(1.327)	(2.040)	(1.614)	(2.141)
Supply elasticity	-0.0220	-0.0584**	-0.0599	-0.127***	-0.165**	-0.101**	-0.129*
	(-1.057)	(-2.169)	(-1.551)	(-3.260)	(-2.542)	(-2.293)	(-1.679)
ln(Population)				-0.0672**	-0.0779**	-0.0468	-0.0606*
				(-2.388)	(-2.275)	(-1.505)	(-1.745)
ln(Per capita personal income)						-0.423*	-0.415
						(-1.949)	(-1.149)
ln(Per capita personal investment income)				0.0145	-0.114	0.208	0.0970
				(0.178)	(-0.866)	(1.634)	(0.410)
Max. state tax rate for long term capital gain				0.0102**	0.00943	0.0129***	0.0122*
				(2.046)	(1.296)	(2.678)	(1.689)
Northeast region				-0.129	-0.0935	-0.100	-0.0623
				(-1.305)	(-0.684)	(-0.990)	(-0.444)
South region				0.128*	0.184*	0.111	0.163
				(1.716)	(1.737)	(1.471)	(1.540)
West region				-0.0411	0.0599	-0.0390	0.0721
				(-0.537)	(0.578)	(-0.509)	(0.700)
Constant	-0.772	-0.706	-2.726**	0.173	-0.358	2.275*	1.608
	(-1.557)	(-1.027)	(-2.366)	(0.193)	(-0.239)	(1.932)	(0.783)
Observations	2,226	1,113	556	1,113	556	1,113	556
Number of MSAs	74	71	58	71	58	71	58
Adjusted R-squared	0.005	0.008	0.023	0.018	0.037	0.020	0.037

Table 7 – Regression Results on City-specific Managerial Equity Incentives

Dependent variables	(1) Beta	(1) Beta	(2) Beta
Sample range	Full sample	Supply elasticity ≤Median	Supply elasticity ≤25%
ln(Median home price)	0.0878*	0.184***	0.167*
	(1.865)	(2.652)	(1.829)
ln(MSA vega)	-0.00693	0.140***	0.202***
	(-0.280)	(2.922)	(3.324)
ln(MSA delta)	0.0159	0.0107	0.0764
	(0.424)	(0.278)	(0.973)
Supply elasticity	-0.0263	0.0249	-0.0375
	(-0.832)	(0.384)	(-0.129)
ln(Population)	-0.00943	-0.0602*	-0.0803*
	(-0.348)	(-1.778)	(-1.855)
ln(Per capita personal income)	-0.314*	-0.749***	-1.353
	(-1.736)	(-2.791)	(-1.605)
ln(Per capita personal investment income)	0.174*	0.439**	0.733
	(1.674)	(2.323)	(1.418)
Max. state tax rate for long term capital gain	0.0110**	0.00565	0.00140
	(2.180)	(0.879)	(0.162)
Northeast region	-0.0490	-0.0682	-0.0607
	(-0.636)	(-0.785)	(-0.544)
South region	0.0441	0.0401	-0.0877
	(0.851)	(0.492)	(-0.343)
West region	-0.0106	-0.0863	-0.0567
	(-0.188)	(-1.285)	(-0.520)
Constant	0.981	2.408*	6.247
	(0.794)	(1.663)	(1.461)
Observations	2,213	1,261	717
Adjusted R-squared	0.005	0.022	0.027

Appendix A. Variable Definitions

Beta: The sum of beta coefficents in Equation (1), where

$$
\begin{aligned}
R_{ZIP,t} - R_{F,t} = \alpha_{ZIP} &+ \phi_{ZIP}^{-1}(R_{ZIP,t-1} - R_{F,t-1}) \\
&+ \phi_{ZIP}^{-2}(R_{ZIP,t-2} - R_{F,t-2}) + \beta_{ZIP}^{0}(R_{M,t} - R_{F,t}) \\
&+ \beta_{ZIP}^{-1}(R_{M,t-1} - R_{F,t-1}) + \beta_{ZIP}^{-2}(R_{M,t-2} - R_{F,t-2}) \\
&+ \tau_{ZIP}^{0}(R_{B,t} - R_{F,t}) + \tau_{ZIP}^{-1}(R_{B,t-1} - R_{F,t-1}) \\
&+ \tau_{ZIP}^{-2}(R_{B,t-2} - R_{F,t-2}) + \varepsilon_{ZIP,t}, \qquad (1)
\end{aligned}
$$

where $R_{ZIP,\,t}$ is quarterly percent change in median home prices at a ZIP Code. $R_{F,\,t}$ is the quarterly risk-free rate. $R_{M,\,t}$ is the quarterly return on the CRSP value-weighted equity portfolio. $R_{B,\,t}$ is the quarterly return on 10-year U.S. Treasury notes.

CEO Pay: CEO total pay, which is CEO's tdc1 in Execucomp. Prior to December 2006, TDC1 was Salary + Bonus + Other Annual + LTIP Payouts + Restricted Stock Grants + Value of Options Granted+ All Other. After December 2006, TDC1 was Salary + Bonus+ Non-Equity Incentive Plan Compensation + Grant-Date Fair Value of Stock Awards + Value of Options Granted + Other Compensation, adjusted to the 2004 USD.

CEO Incentive%: CEO incentive-based pay, scaled by total pay. (Total Pay - Cash Pay) / Total Pay.

CEO Delta: Pay-for-performance sensitivity, the change in the dollar value of the CEO's stock and option portfolio for a 1% change in stock price, adjusted to the 2004 USD.

CEO Vega: Pay-for-volatility sensitivity, the change in the dollar value of the CEO's stock and option portfolio for a 0.01 change in stock volatility, adjusted to the 2004 USD.

H_CEO Incentive%: equals to one when CEO Incentive% is in the top tercile.

H_CEO Vega: equals to one when CEO Vega is in the top tercile.

POP_{MSA}: Number of population by MSA in the year of 2000.

Firm Size: Market capitalization of the firm at the end of fiscal year, adjusted to the 2004 USD.