

Overcoming Basis Risk as a Major Obstacle in the Adoption of Housing Futures as a Hedge

A Quantitative Analysis of the Basis Risk of Using MSA Level Exchange Traded
Housing Futures to Hedge Specific Property Investments

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1. Introduction

As derivatives have grown in importance and in market size over the last three decades, they have contributed to the transparency, sophistication, maturation and even the stability of a variety of markets from foreign currency exchange to energy. It is only logical to believe that the march of evolution will eventually introduce derivatives en masse to one of the largest and most widely held asset classes in the world: housing. Because of the size and characteristics of housing, derivatives offer significant value for this asset class as a means to facilitate risk transfer, foster better stability, and expand investment opportunities to institutional and individual investors.¹ Because of the long-understood value of real estate's differing return and risk profile in a well diversified portfolio, demand should exist as soon as the market for derivatives becomes mature enough to attract appropriate attention as it will enable the capture of the majority of the diversification benefits without the inefficiencies and transaction costs of actually buying, managing and selling real physical properties.

The Chicago Mercantile Exchange (CME) began trading futures and options in May 2006 based on the Case-Shiller Repeat Home Price Index for 10 Metropolitan Statistical Areas (MSAs).² One purpose of these instruments is to allow homebuilders to hedge the risk of price declines between the time an initial investment is made in the raw land and up to the time when the project is completed and the final homes are sold. It is logical to expect that large production builders would be interested in hedging property investments since the most consistent metric used to value the market worth of public builders has been the price-to-book ratio, which for a builder is almost completely based on their land investments, work-in-process inventory, and speculative inventory. Additionally, housing futures have the potential to provide individual homeowners protection against MSA wide declines, something that has even been mentioned as a likely innovation to be explored by builders to calm buyers' fears in a turbulent market³.

We have been witnessing market turbulence and rare real pricing declines ironically since the CME Housing Futures began trading, yet builders do not appear to be lining up to use the futures to hedge their very real

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¹ "CME Housing Futures and Options," Chicago Mercantile Exchange, available at http://www.cme.com/files/cmehousing_brochure.pdf.

² The initial MSAs were Boston, Chicago, Denver, Las Vegas, Los Angeles, Miami, New York, San Diego, San Francisco, and Washington DC.

³ Eisenberg, Elliott F., Ph.D., "Housing Futures and Options," April 18, 2006, www.housingeconomics.com.

risk.⁴ This is a troubling dilemma because in order for housing derivatives to grow there needs to be an adequate supply of hedgers seeking to use the derivatives to reduce the risk of potential future movements in housing prices contrary to their actual physical positions.⁵

Understanding and overcoming the factors that are contributing to this reluctance to utilize them are keys to helping housing derivatives grow and mature. In this paper, the authors will share the initial results of their efforts to study one of the most significant inhibitors to builders adopting the current exchange traded products: the purported blunt nature of the market-based futures and options that presumably carry significant basis risk.⁶

The purpose of this paper is to examine how much of a hedge against price decline these MSA level instruments can really provide. Homebuilders (and particularly individual homeowners) do not necessarily own portfolios of homes distributed randomly across a city, but own particular homes in particular neighborhoods, where home prices may or may not appreciate identically to the MSA level Case-Shiller index.

For our initial analysis, we produced a repeat sale index at the neighborhood level for Chicago and Denver, and used it to measure the correlation between home appreciation at the neighborhood level and the MSA level. Neighborhoods, for the purpose of this paper, are census block groups. Block groups are established by the Census Bureau and optimally have a population of 1,500 people.⁷ There are 5,889 block groups in the Chicago MSA and the 1,941 block groups in the Denver MSA. The repeat sales index we created for each block group effectively breaks the Chicago MSA into 5,889 neighborhoods and the Denver MSA into 1,941 neighborhoods. Measuring the relationship between the block group price index and the MSA price index produced by Case-Shiller will demonstrate, on a neighborhood by neighborhood basis, the amount of protection CME futures and options can potentially provide.

⁴ No quantitative statistics can back up this claim but judging from the thin trading volume of the housing futures and adding anecdotal comments from executives at large homebuilders, we see no evidence of sincere interest in utilizing housing futures as a hedge.

⁵ Hull, John C. *Options, Futures, and Other Derivatives*, Sixth Ed., Prentice Hall, 2006, p. 8.

⁶ Eisenberg and others have identified basis risk as a key concern, and specific sources of the basis risk include the risk that the specific location does not behave like the overall market of the index and that the time frame of the contracts offered for the futures do not align well with the typically longer time horizon of purchasing, entitling, developing and delivering individual homes on a tract of land. Since the time frame issue may be overcome with laddering or more complex hedging strategies, we focused our attention on the basis risk involving a specific property not behaving like the MSA in which it is located.

⁷ http://www.census.gov/geo/www/cob/bg_metadata.html.

Section 2 of this paper reviews the literature on repeat sale indexes. Section 3 describes the data source and technical method followed to create block level repeat sale price indexes. Section 4 describes the techniques used to measure the relationship between the block group price indexes and the Case-Shiller MSA price index. Section 5 presents the results of the analysis, and Section 6 discusses the implications of our analysis.

2. Home Price Indexes

There are two approaches used to create home price indexes. The first approach creates what is known as a hedonic index. A hedonic index is based on a regression that uses a home's attributes to explain its price. A home's attributes include, but are not limited to, its size, number of bedrooms, and number of bathrooms. The result of the technique is that each attribute for each market in each time period has a price, and the collective prices can be used to construct a hypothetical house with identical attributes in different markets or in the same market for different time periods. Since the attributes of the hypothetical home are identical, the price of this hypothetical home acts like a price index. Any variation in the price of this hypothetical home is assumed to represent a change in the general cost of housing. The problems with the hedonic approach to calculating price indexes are that it requires a great deal of detail about each home in each market to calculate and that it is difficult to account for every home attribute.

The methodology to produce a repeat home sale index was first published by Baily, Muth and Nourse in 1963.⁸ Repeat sale home indexes improve upon both of the major problems with hedonic indexes. While a hedonic index attempts to price homes by controlling for every possible attribute, a repeat sales index controls for changes in attributes by focusing on the resale of the same home at different times, which largely guarantees identical attributes. Thus, repeat sale indexes produce indexes that better control for home attributes and require less data detail than hedonic price indexes.

Karl Case and Robert Shiller first produced the repeat home sale price index, on which the CME options are based, for a 1987 academic paper.⁹ They improved upon the Baily, Muth and Nourse techniques in at least two ways. First, they used a data set with additional information about home attributes to make sure that resold homes do not change in any appreciable way between sales. Second, the homes that go the longest between sales often show the most price appreciation, and therefore have the most impact on the estimation of the index, but are also homes most likely to experience changes in attributes. This causes the estimation to be potentially biased toward the appreciations suggested by the longest tenured resale. To correct for this

⁸ Bailey, Martin J., Richard F. Muth, and Hugh O. Nourse. 1963. "A Regression Method for Real Estate Price Index Construction," *Journal of the American Statistical Association* 58: 933-42.

⁹ Case, Karl E., and Robert J. Shiller. 1987. "Prices of Single-Family Homes since 1970: New Indexes for Four Cities," *New England Economic Review* (September/October): 45-56.

heteroscedasticity, Case and Shiller use a three stage regression technique that was unavailable to Baily, Muth and Nourse.

The details of the methodology Case and Shiller use to produce their current repeat sale index is proprietary, but is most likely similar to that described in their 1987 paper. Standard and Poor's does provide a document¹⁰ outlining the general process used by Case and Shiller to produce their index. In general, the current process looks at all home transactions to create matched pairs of resold homes. Any homes transacted within families are tossed out, so that the prices of all remaining homes can be assumed to have transacted at the market price. The appreciation for each pair is then calculated, and each pair is assigned a weight that affects its impact on the final price indexes. Pairs that have transacted too often, too rarely, or those with appreciations greatly above or below market average are given low weights because homes involved in all three cases are unlikely to have maintained constant attributes. A weighted regression is run to estimate each index on a monthly basis, and a three month moving average for each MSA is published.

3. Technical Discussion of Data and Analysis Technique

As a point of comparison, two MSAs covered by the initial group of Housing Futures were chosen for analysis. To generate a repeat home sale index on the block level for Chicago and Denver, a dataset from HousingIntelligence.com was used. This complete proprietary dataset contains data on over 140 million US properties and transactions of single-family detached homes, townhomes, condominiums and multiplexes. All records with prior sale information¹¹ for the Chicago and Denver MSA were pulled for this analysis, with the following exceptions. To avoid including atypical repeat sales in the index, homes that transacted more than once in a single year were excluded. In addition, to avoid the potential bias caused to indexes by any extremely long tenures between transactions, any homes that went more than 10 years between sales were removed. The final dataset used to create the block group level indexes has 425,645 matched pairs for Chicago and 287,075 matched pairs for Denver.

The process of creating a repeat sale price index involves using a special regression technique, which is described below. Though it is complicated, the regression can be thought of as performing the following

¹⁰ The Document can be found at:

http://www2.standardandpoors.com/spf/pdf/index/SP_Case_Shiller_Home_Price_Indices_Methodology_Web.pdf.

¹¹ Using prior sale data potentially limited the number of records and also limited our ability to control for additions made between sales. We used this technique to limit the amount of effort required as we determined the value of the analysis. Future research will involve matching repeat sales from the database based on address, which will greatly increase the number of pairs used in producing the index and will enable better control of significant changes to the homes.

process. Imagine a chart that shows years on the x-axis and home prices on the y-axis. Then, for a particular city, plot a single home's first sale price in the year it occurred, and its final sale price in the year it occurred. Connect the points, and the slope of that line represents the annualized appreciation of the home. Now do that for an additional one-thousand homes. Each year will have numerous lines crossing and representing numerous appreciation rates experienced by homes in this city. If you were to take the appreciation rate from each line crossing through a single year and compute the average, you would have the average appreciation for that year. Because all the homes involved in generating the appreciations and average appreciations are repeat sales with no change in attributes, this calculated average appreciation can serve as an index applicable to all homes in the area. This averaging of appreciations for each year is exactly the task the regression described below performs.

To construct the repeat sales indexes, the basic model from Case and Shiller's 1987 paper was used. The dependent variable in this regression is each pair's total appreciation, and the independent variables consist of a series of dummy variables, one for each year since 1986. For each matched pair of homes, a -1 is entered into the dummy for the year of the home's first sale, a 1 is placed in the dummy for the year of its second sale, and zeros are entered into all the other years. The regression was then run once for each block group in Chicago and Denver, using the Huber/White/Sandwich correction to control for any potential heteroscedasticity in the data. The resulting betas from each regression indicate the log price index, and the difference between any two years coefficient can be interpreted as the log percent change of prices between those two years.

The coefficients from each block group's regression were then converted into a standard price index by the following process. Each block group's base year, which varies based on data availability, was given a value of 100. Its level then varied based on the appreciations generated by differencing each year's coefficient for each block group, with log percentage changes converted to standard percentage changes based on the method suggested by Halverson and Palmquist.¹²

For our analysis, the annual repeat sale price index created at the block level was compared to the Case-Shiller repeat sales index. The Case-Shiller monthly index for MSAs is available to download at the Standard and Poor's website.¹³ To turn the monthly index into an annual index for direct comparison with the block group indexes created in this paper, the monthly indexes were averaged for each year.

¹² Halverson, Robert and Raymond Palmquist. 1980 "The Interpretation of Dummy Variables in Semilogarithmic Regressions," *American Economic Review* 70 (June): 474-75.

¹³ <http://www.metroarea.standardandpoors.com>.

4. Model for Comparison

To test the relationship between the Case-Shiller MSA level repeat sale indexes and the block group level repeat sale indexes created for this paper, two common statistical measures were computed for each block group.

The first measure was r-squared. If the MSA and block group indexes are highly correlated, they should exhibit a strong linear relationship. In other words, the pattern of appreciation in the MSA level index's experience should mirror the appreciation experienced at the block group level. If the linear relationship between a block group and MSA index is strong, a builder or homeowner within the block group will be able to use instruments based on the MSA index to hedge their risks. If the linear relationship is weak between the block group and MSA, a homeowner or homebuilder would not be able to hedge their risks. R-squared measures the strength of a linear relationship. It varies between 0 and 1, with the strength of the linear relationship increasing as r-squared approaches 1. Any r-squared greater than .6 would signify a very strong relationship between the MSA level index produced by Case-Shiller and the price index created in this paper at the block group level. A strong relationship is a better candidate for the MSA level index as a hedge.

The second measure used to quantify the relationship between the Case-Shiller MSA level repeat sale price index and block group level repeat sale index created for the paper was the financial measure of risk known as *beta*. Beta is a key statistic used to determine the relative risk associated with individual stocks compared to the entire stock market or a comparable index. The beta of an investment is therefore a way to measure the risk of a particular investment compared to the broader market based on the relative volatility. The beta of a specific investment reveals if a particular asset is more or less volatile and therefore judged riskier than the comparable stock market index. If an asset has a beta of 1, its volatility makes it no more or less risky than the market.

For the purposes of this analysis, we wanted to know the relative volatility of housing returns in the individual block groups relative to the housing returns for the MSA index produced by Case and Shiller. For each block group, an estimate of beta was constructed for the year-over-year appreciation in each block group relative to the year-over-year appreciation in the Case-Shiller MSA Index.

The resulting betas were interpreted in the following fashion. Block groups that have a beta close to 1 (between 0.5 and 1.5) move consistently with the MSA index and thus can be effectively hedged in a relatively straight forward fashion using instruments based on the MSA index. Block groups that have a beta greater than 1.5 move more significantly than the MSA index. This means that when the MSA index indicates a home price increase of 3%, a block group with a beta greater than 1 should show an appreciation greater than 3% since a higher variance or risk profile is associated with that block group. It also means that a block group with a beta greater than 1.5 will also show a bigger decline than the MSA when the MSA index

declines. Therefore, block groups with betas more than 1.5 can only partially be hedged with simple short sales of the MSA index.¹⁴ Block groups that have a beta less than -0.5 were inversely correlated with the MSA and therefore either exhibited negative appreciation when the MSA index experienced positive appreciation or experienced positive appreciation when the MSA index experienced negative appreciation. Properties in block groups with negative betas close to -1 could be hedged effectively with purchases of the future contracts based on the MSA index. Those block groups that have a beta between -0.5 and 0.5 have a very weak relationship with the MSA index, moving essentially independently. This makes hedging such block groups within the MSA index relatively useless.

5. Results

The results from calculating the r-squared correlation for each block group against the Case-Shiller MSA index for Chicago and Denver can be found in Table 1. In Denver, 85.9% of the block groups have an r-squared greater than .6 and in Chicago 71.3% of the block groups have an r-squared greater than .6.¹⁵ This means that homeowners, builders or developers in 86% of Denver's neighborhoods and 71% of Chicago's neighborhoods could effectively hedge the risk associated with home price variation by shorting the exchange traded contracts based on the Case-Shiller MSA index.

Figures 1 and 2 present maps that illustrate the distribution of r-squared values across Denver and Chicago. It is clear that though the majority of block groups in both cities have high r-squares, there are numerous places in both cities where the Case-Shiller MSA index has no explanatory power. Homeowners living in these areas and companies developing land and building in these areas would get limited benefits from attempting to hedge their investments using exchanged traded contracts based on the MSA index.

The results from calculating the beta for each block group against the Case-Shiller MSA index for Chicago and Denver can be found in Table 2. 53.3% of block groups have a beta between 0.5 and 1 in Denver, and only 21.5% for Chicago.¹⁶ Therefore those who expect to hedge a real property investment in the remaining

¹⁴ While it is possible to construct a hedge portfolio using the beta and the investment and index relative prices, we are assuming that if there is an alternative to construct a hedge using the neighborhood block group that such a hedge will cover the basis risk more effectively. Regardless, understanding the beta value is key to deciding if and how to utilize the MSA level index as a hedge.

¹⁵ 67 Block groups in Denver and 510 block groups in Chicago did not contain enough repeat sale pairs to generate an index sufficient to calculate an r-squared.

¹⁶ 74 Block groups in Denver and 1,657 block groups in Chicago did not contain enough repeat sale pairs to generate an index sufficient to calculate a beta.

neighborhood block groups would need to factor the beta into their hedging strategy or seek an alternative hedge instrument that more closely matches the property investment.¹⁷

Figures 3 and 4 present maps that illustrate the distribution of beta across Denver and Chicago. It is clear that beta, and therefore risk, is randomly distributed over neighborhoods in both markets.

6. Conclusions

Our initial analysis has revealed that, at least within the two sample markets chosen, exchange traded futures based on the MSA level Case-Shiller indexes do correlate strongly with the majority of the neighborhoods in which real properties reside. However, there is significant basis risk for those neighborhood block level groups that are not correlated with the MSA level index. Furthermore, there is significant variation in risk across neighborhoods as measured by their betas or relative volatility compared to the MSA level index. This implies that even when there is tight correlation, the relative volatility needs to be taken into consideration in order to have an effective hedging strategy.

As this paper was based on a limited study of two markets, further study is called for to determine if these findings are representative of all markets with exchange traded futures and more broadly for more markets against standard price indexes. The most significant finding of this paper is the value of applying effective price index calculation methods at a much more granular level than is typically available and studied today to derive subsequent metrics that can reveal much needed information about the behavior and risk profile of neighborhoods relative to the overall market.

For the investor, whether a builder, developer, or an individual home buyer, understanding the beta and the r-squared of the individual neighborhood in which their property investment resides is extremely valuable and necessary for any truly effective hedging strategy to be designed and implemented. Neither measure alone is enough. The r-squared tells the investor whether the index of the neighborhood tracks well with the index, and the beta tells the investor how to adjust the use of (long or short) or number of the exchange traded contracts in order to hedge the investment effectively.

¹⁷ An alternative strategy that might better manage basis risk and overall volatility risks would be to explore over the counter return swaps based on a price index calculated at a neighborhood block group level. The ability to calculate an appropriate index, which we have demonstrated here, is the key to developing such instruments.

The r-squared and beta also reveal that for certain property investments, a neighborhood-specific swap transaction could be far more appropriate given the proper information to facilitate the design of such a transaction.

We hope that this initial effort and our continuing analysis of neighborhood level price changes relative to the MSA provide an understanding as well as the insights and data needed to spark innovation that can overcome the basis risk challenges that may be standing in the way of broader adoption of housing futures as appropriate hedging strategies.

For a copy of this paper or to access future updates or information about the availability of neighborhood level price indexes, please visit www.bluesmoke.biz or www.housingintelligence.com.

Table 1 - R-squared by Block Group

Denver (1944 Total Block Groups in MSA)		
R-squared	Count	Percentage
1.0 - 0.8	1385	73.8%
0.6 - 0.8	227	12.1%
0.4 - 0.6	70	3.7%
0.2 - 0.4	56	3.0%
0.0 - 0.2	139	7.4%
Insufficient Data	67	

Chicago (5889 Total Block Groups in MSA)		
R-squared	Count	Percentage
1.0 - 0.8	2705	50.3%
0.6 - 0.8	1127	21.0%
0.4 - 0.6	533	9.9%
0.2 - 0.4	373	6.9%
0.0 - 0.2	641	11.9%
Insufficient Data	510	

Table 2 - Beta by Block Group

Denver (1941 Total Block Groups in MSA)		
Beta	Count	Percentage
Greater Than 1.5	363	20.6%
Between .5 and 1.5	937	53.3%
Between -.5 and .5	301	17.1%
Less than -.5	158	9.0%
Insufficient Data	182	

Chicago (5889 Total Block Groups in MSA)		
Beta	Count	Percentage
Greater Than 1.5	760	18.0%
Between .5 and 1.5	908	21.5%
Between -.5 and .5	1451	34.3%
Less than -.5	1113	26.3%
Insufficient Data	1657	

Figure 1 - Denver R-Squared by Block Group

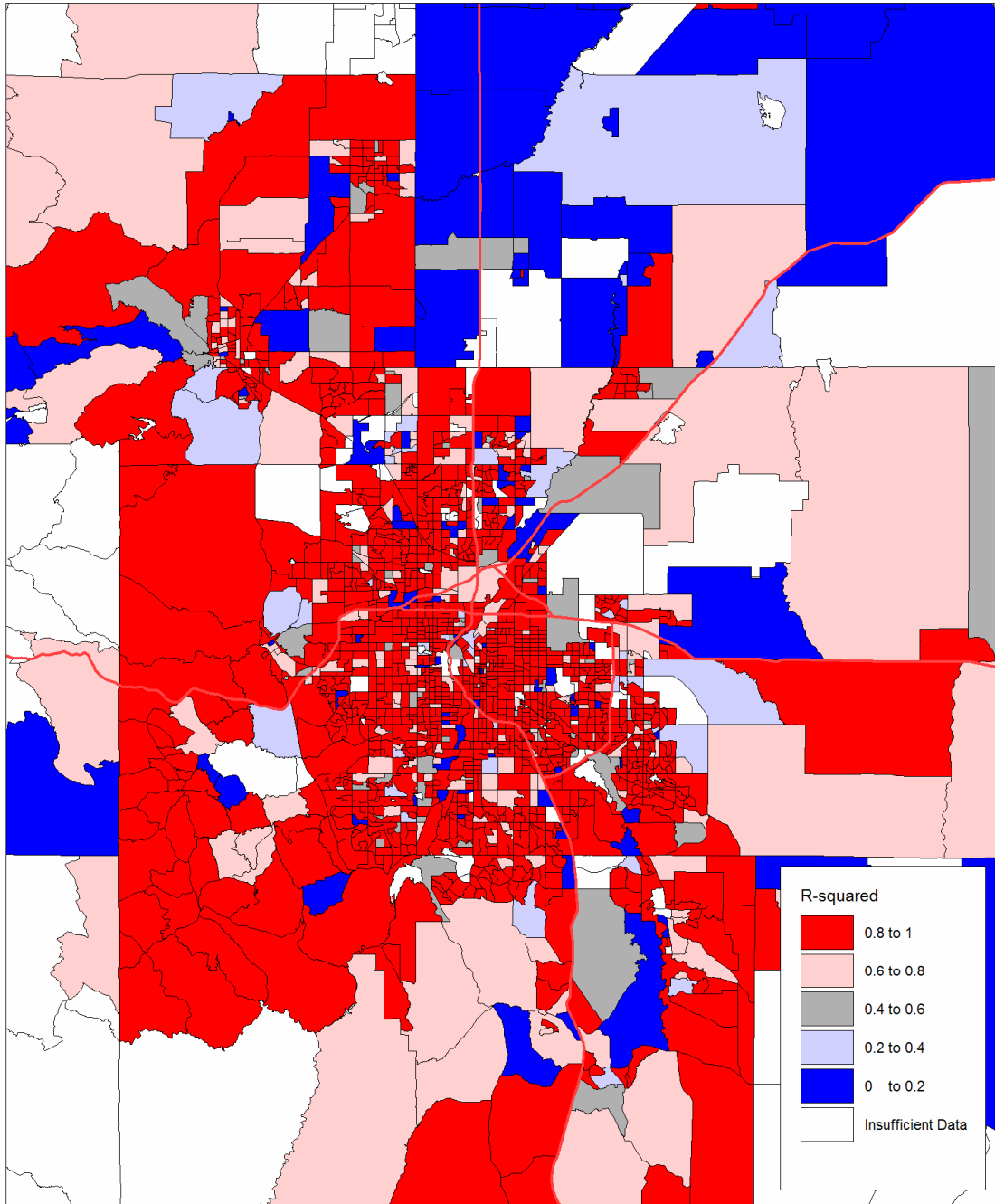


Figure 2 - Chicago R-Squared by Block Group

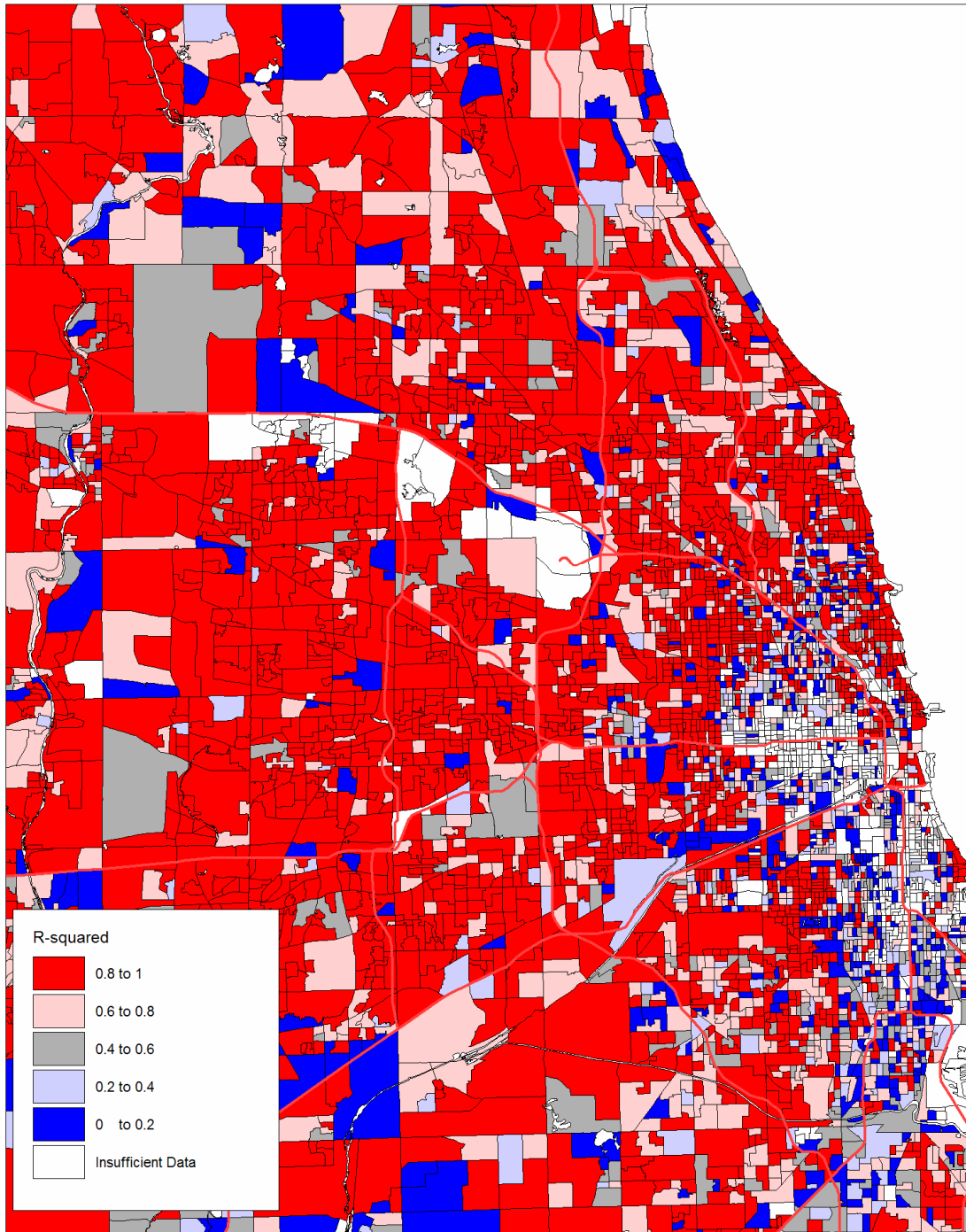


Figure 3 - Denver Beta by Block Group

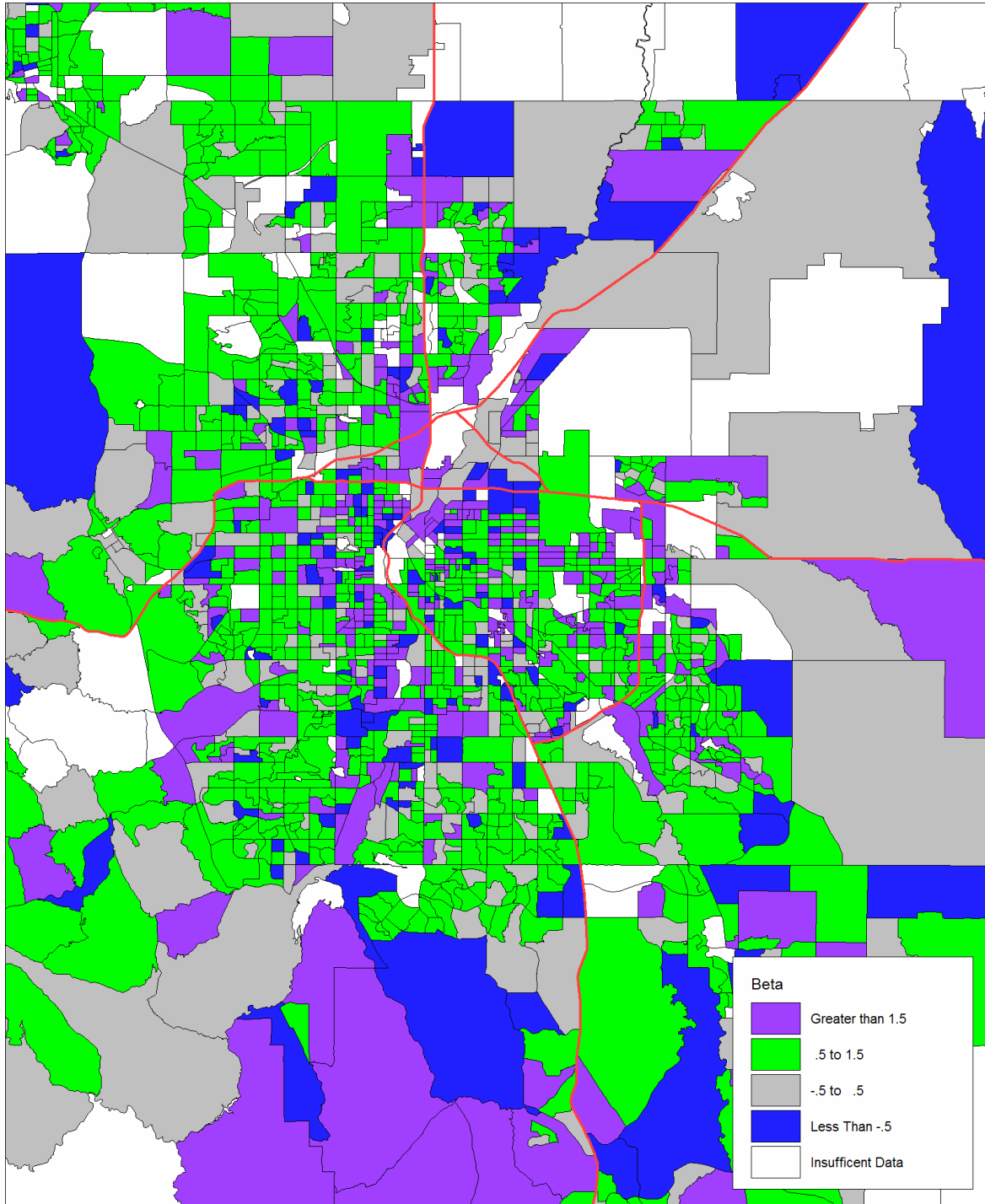


Figure 4- Chicago Beta by Block Group

