An Analysis of Appraised Values and Actual Transaction Prices in the US CMBS Market

By

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Submitted to the Department of Architecture in Partial Fulfillment of the Requirements for the Degree of

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Abstract

This thesis addresses the characteristics of transaction-based indices and appraisal-based indices and compares the difference between appraisal and transaction price in the United States Commercial Mortgage-Backed Securities (CMBS) market. The examination is based on the transaction database of Real Capital Analytics, Inc (RCA). A hedonic regression model is applied to data for the period 2000-2006 to produce national indexes at the all-property, office and retail levels. The hedonic model examines the relationship between appraised value or transaction price and NOI, property characateristics, and time. The results are used to create price and appraisal indices. Moreover, the results also prove that multivariate regression analysis is a cost-effective statistical procedure for estimating property values in a time-varying approach.

Despite the charcteristics influence on price, the relationship between transaction and appraisal behavior is demonstrated in this article. The transaction-based index reflects the timing and changes of market price more accurately and effectively than appraisal-based index does during the examination period. Comparing two appraisal indices, the one without transactions (refinancing) is less volatile than the one with transactions (sale). The underlying reason is appraisers have more pressure when there is a transaction occurred comparing with only for refinancing deal. Therefore, they will appraise those properties with transactions higher than refinancing ones.

In addition, after comparing appraisal index without transaction (refinancing) and transaction index (sale), I learn that transaction index for sure leads appraisal index at least one period due to its lagging issue. Therefore, we can predict appraisal index return based on transaction index.
These findings are very important for investors when valuing their investments. Those constructed indices can be used to track market trends and to support tradable commercial property price derivatives in the near future.

Thesis Advisors: Henry O. Pollakowski
Title: Principal Research Associate

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TABLE OF CONTENTS

Chapter One: Introduction of Real Estate Index and Literature Review

1.1 Introduction

The purpose of this thesis is to compare an appraisal index with a transaction index for properties in the Commercial Mortgage-Backed Security (CMBS) market. The data used are provided by Real Capital Analytics (RCA), Inc, a New York based real estate investment analysis firm.

My further interests are in several areas related to those indices. Firstly, I would like to find out what a transaction index looks like based on RCA data set in CMBS market, is it more volatile than appraisal index. Secondly, I am interested in comparing a pure transaction index with an appraisal index in the sale market, a pure transaction index with an appraisal index for refinancing, and an appraisal index for refinancing with an appraisal index for sale in order to examine their relationships. Furthermore, appraisers behavior influence the appraisal value significantly, and they act differently when there are transactions involved. In this thesis, I hope to find how their behaviors affect different indexes and what those differences are when there is a transaction involved or not.

Compared to stocks, the long run performance of real estate has been less well known. The reason behind this is that indices of real estate returns are fundamentally different from stock indices. It is relatively easy to construct a long run stock index, since stock prices are public information. And for most countries, these prices have been published since the establishment of the stock market. But for real estate, prices are not public in most countries, which makes exact

information about real estate performance a scarce commodity for the present, let alone for the distant past. The limited availability of commercial real estate data is the result of characteristics of commercial markets, such as low transaction volumes, no central trading place, and no centralized data collection.

Real estate research indices include three types of indices to measure real estate values: appraisal-based, property share-based and transaction-based indices. The first two types are hardest to expand into the past. Generally speaking, transactions-based indices are preferable to appraisal-based indices because of the sensitiveness to lag bias and random error. Except for indices tracking small populations of properties where transaction density is less than two or three dozen observations per index reporting period, transactions-based indices minimizing the MSE criterion can be produced with no temporal lag bias.

Understanding these indices helps real estate professionals understand the motivations of institutional investors when purchasing, valuing and selling real estate income property. These indices can also be used to track trends in real estate values and capitalization rates for different property types and geographic areas. Before reviewing those indexes in details, we need to clarify the meanings of appraisals, transaction price and market value. According to Geltner and Ling's article (2006), transaction price and appraisal are empirically observable values, but only occurred when a property transacts or is appraised.[1] In contrast, market value is the true value, existing for each property at each point in time.

[1] Geltner and Ling (2006), Considerations in the Design and Construction of Investment Real Estate Research Indices

1.1.1 Appraisal-Based Indices

Indices of the price performance of commercial real estate are important for various investment groups, such as private market investors, pension funds, institutional investors, and foreign investors. Traditionally, appraisal-based indices had been used broadly to estimate an underlying purchase offer and to measure the volatility of a commercial property. It is well known that these indices suffer from lag smoothing and seasonality problems. Therefore, using the Russell-NCREIF index, for example, in asset allocation decisions might be incorrect because the estimated correlations of real estate with other assets and the estimated volatility of real estate tend to be biased. These days, more and more problems have been discovered by using solely appraisal-based indices in commercial real estate. These problems include the use of stale appraisals and appraisal lags.

For the purpose of perceiving private real estate with a degree of credibility and legitimacy, real estate investment industry leader decided to report a periodic real estate return like those in the bond and stock market. NCREIF Property Index (NPI) was established to report quarterly property return, income and appreciation in 1978. On January 1, 1995, NCREIF assumed full responsibility for the index, including its publication and distribution. The index became the NCREIF Property Index (NPI), a flagship index.

Since NPI has been in the industry for decades, it is an indicator of real estate's long-term average investment performance and a benchmark for investors and managers to evaluate the

properties' performance.[2] It is important to note that the NCREIF Property Index (NPI) consists of both equity and leveraged properties, but the leveraged properties are reported on an unleveraged basis. So, not like CMBS index, the NPI is completely unleveraged. Appraisals are based on market value for client reporting. Normally, there is an independent appraiser who does the work once a year, and an internal one who does the quarterly work. The beginning and ending values used to calculate the NCREIF index are based on appraisals.

Appraisal-based indices track a particular sub-population in which all properties are appraised at the same period. It uses the average appraised value to represent value at time t (V_t) in the index return: $A_t \approx V_t$.[3] Appraisal-based indices are constructed similar to the way many institutional "core" funds, which are marketed and reported returns to the investors. Obviously, appraisals are subjective and backward-looking. In addition, not all properties are seriously reappraised every quarter (normally at the end of each year) and thus the reported value remains constant even though the market is changing. This "stale appraisal" problem makes NPI more like a yearly index rather than a quarterly one.

Appraisal-based indices have various drawbacks which have been well documented in the literature. Most of these are related to the lack of independence between observations. To make a long term appraisal-based index, a problem of consistency in the appraisal method is added to this: if appraisal methods change over time, the outcomes become incomparable. Therefore, indices based on these appraisals would have major drawbacks while historic series of real estate appraisals are probably available in countries where property taxes have been levied.

[2] See Fisher & Geltner (2000), De-Lagging the NCREIF Index: Transaction Prices and Reverse-Engineering, *Real Estate Finance Spring 2000.*
[3] Quoted from Advanced Topics in Real Estate Finance & Investments Spring 2007 slide10.

It is apparent that appraisal based indices have less volatility and lag changes. One reason, mentioned above, is no property is reappraised every quarter. The other reason is the lag issue. Index value tends to be a blend of current and recent past population values. Appraisal-based indices, such as NPI, are influenced by the appraiser's behavior. Therefore, this will cause lagging on periodic returns series. Such lag smoothing is often attributed to the valuation.[4]

In recent years the demand of using NCREIF Property Index (NPI) has expanded greatly, however NPI has difficulty providing information on current asset market value changes. In addition, NPI has a spillover effect when it provides accurate quarterly indications of market changes. The new transaction-based index (TBI) uses sophisticated statistical techniques and proprietary transaction data to create a more accurate and representative index based on actual commercial real estate transactions.

In addition to the above general conclusions, a "non-traditional" appraisal-based index can be imagined that might include the major advantages of both the traditional appraisal-based index and the transactions-based index. If the regular property appraisals in the population could be made independent of any lagged property market information, they would not have the lag bias problem. To accomplish such a possibility, new appraisers have to be hired for each reappraisal, without the previous appraisal report, and thus each appraisal would be truly independent of any prior appraisal. Furthermore, the appraisers would have to be instructed to only use comparable sales from the current index reporting period. Such appraisals would violate traditional appraisal

[4] See Geltner & Pollakowski (2006), A Set of Indexes for Trading Commercial Real Estate Based on the Real Capital Analytics Transaction Prices Database, *page 2.*

practice guidelines, and would no doubt not be optimal for individual property value estimation, but when aggregated into an index, they would provide a more effective source of data for estimating the population market value.

1.1.2. Transaction-Based Indices

Transaction price indices are based directly and purely on contemporaneous transaction prices of the sample of properties each period. Those indices use statistics and econometrics to estimate population return and price change in each period. Moreover, their careful and sufficient data and state-of-art econometric procedures can manage "apples-vs-oranges" differences in properties trading at different times. They can also minimize random deviations from population prices and overcome those lagging issues faced by appraisal indices.

Liquidity in private asset markets is notoriously variable over time. Therefore, indices of changes in market value that are based on asset transaction prices will systematically reflect differences in the ease of selling a property. Market liquidity and transaction prices are related. The former refers to the ease with which properties transact or are expected to transact. Transaction frequency is one way to measure market liquidity and is positively correlated with the asset market cycle. However, transaction price affects the frequency and the frequency determines the price as well.

Transaction-based indices have been used very broadly in the residential market, but still face difficulties in the commercial real estate market. This is because transaction price data in

commercial real estate is traded in private markets and is unique between individual buyer and seller. This unique individual trading occurs infrequently and irregularly through time. It is therefore hard to submit a periodic report showing the transaction process. As we can see, the more transactions which happen per period, the more data can be collected and the more the report will be used.

We can easily illustrate the difference between appraisal-based indices and transaction indices by using either the NPI or RCA index. The former is based on appraisals, the latter is based on transactions. This thesis will use RCA data set to compare the difference between appraisal and transaction price. RCA index, the monthly national all-property index, shows signs of peaking or leveling out.[5] Furthermore, not only is the RCA index a monthly index, but also it lacks smoothing. Thus, the RCA index has the ability to detect market movement and to indicate a change in direction at an early stage. In addition, the RCA index tracks larger and broader populations of commercial properties than the NPI or any index based on NCREIF. Certain types of properties have been tracked differently between NPI and RCA. NPI tracks only large properties traded by institutional investors whereas RCA also tracks smaller properties traded by local private investors.

From the above, we can compare the difference between appraisal-based indices and transaction price indices. The appraisal indices only take the evaluation of certain properties and appraisers limit the sample pool. In contrast, transaction-based indices consider a certain amount of transaction price observations. Therefore, the following conclusion can be drawn. Transaction-

[5] See Geltner, Pollakowski (2006), A Set of Indexes for Trading Commercial Real Estate Based on the Real Capital Analytics Transaction Prices Database, *page 4.*

based indices are preferable if the result is more sensitive to temporal lag bias but less sensitive to random error or equally sensitive to both of them. Otherwise, appraisal-based indices are preferable. In addition, appraisal indices are good at tracking property data in certain markets, when those properties are regularly marked. On the rest of the markets, transaction-based indices have more of an advantage in tracking properties.

In conclusion, no methodology or index is perfect, but as data on transactions becomes more available, these indices will become more reliable and allow for better evaluation of the performance of commercial real estate.

1.2 Literature Review

Over the past two decades, commercial real estate investment has gradually made its own way into institutional investor portfolios via private and public equity. Real estate has recently given rise to increase research and analysis from both analysts and academia. Despite the relative pervasiveness of such indices research done in the real estate industry, very few studies or researches have comprehensively analyzed the difference between appraisal value and transaction price in Commercial Mortgage-Backed Security (CMBS) market. The phenomenal rise of commercial real estate offers an interest to me, and the lack of existing literature gives me an opportunity to dig into it in depth, which is why this thesis is written. Moreover, if the market for commercial property derivatives is growing rapidly, so the commercial property indices can be used as the basis for derivative products in the future.[6] During my research, I realized the

[6] For Further information, check Morgan Stanley report (2007), US CMBS Commercial Property Return Indexes: Choosing from the Menu, *February 20, 2007.*

potential importance in modeling commercial real estate market performance by establishing and using indexes.

I found quite a few of reasons for the paucity in literature after conducting my research at the beginning of writing this thesis. The primary and most important one is the availability of related qualified data in the CMBS market, especially the transaction price data. CMBS has such a short history in the real estate industry, in addition to the lack of technology, it was difficult to collect supporting data before 2000. Therefore, I really appreciate RCA's help and support. Without their extensive and comprehensive database, this thesis would not be existed.

Even though there is little literature to review and cite, the existing articles about appraisal indices and transaction indices based on NPI or in the residential industry are abundant. Some information and context are overlapping and some articles indicate the same concepts, which helped to develop this thesis. The relevant literature can be segmented into three categories: the broader literature consisting of discussion commercial price indexes based on NPI database, the good amount of literature managing to develop indices and drawing conclusions in residential market by using Fannie Mae and Freddie Mac monthly data, and relatively small literature that combines indices to compare difference and explain relationships in commercial real estate market.

According to Haurin (2005), using transactions as the basis for a price index causes 'noisy' problems, but there are a few solutions to solve the problems. He also introduced a derived index that provides measures of the value of commercial property and compared various transaction-

based indices with an appraisal-based index.[7] In his article, he also mentioned problems with the hedonic-price method of creating a transactions-based commercial property price index, which I will explain more in the next chapter.

Fisher, Gatzlaff, Geltner and Haurin (2003) find that indices of changes in market value that are based on asset transaction prices systematically reflect intertemporal differences and present an econometric model that allows for estimation of a transaction-based price index.[8]

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Although residential market is different with commercial market in so many ways, a number of quality-controlled transactions-based indices have been published that address similar principles even focusing on housing market in the academic literature. Chinloy, Cho and Megbolugbe (1997) draw three principal conclusions by using generalized autoregressive conditioned heteroskedastic (GARCH) analysis. Their conclusions include three parts: the first is that appraisals are systematically higher than purchase data; then appraisal smoothing does not occur generally; the last one is the appraisal updating rule for the United States appears to involve error correction whereby underappraisals from previous periods are eventually adjusted.[9]

According to Geltner & Pollakowski (2006), there are problems with average prices in property price index construction, causing random error ("noise") and bias in the analysis. They also conclude that tracking the property price movement matters to property investors. Thus, they

[7] See Donald R Haurin (2005), US Commercial Real Estate Indices: Transaction-based and Constant-liquidity Indices.
[8] See Fisher, Gatzlaff, Geltner and Haurin (2003), Controlling for the Impact of Variable Liquidity in Commercial Real Estate price Indices, *Real Estate Economics2003 V31 2: page 269-303.*
[9] See Chinoly, Cho and Megbolugbe (1997), Appraisals, Transaction Incentives, and Smoothing, *Journal of Real EstateFinance and Economics, 14: pg 89-111.*

used different and more rigorous methodology based on regression analysis for constructing transaction-based property market periodic price-change indexes in order to control for differences of transacting properties in adjacent time, while also minimizing random error ("noise").[10]

Furthermore, Real Estate is not an isolate industry, transaction price is influenced by so many various factors. Malpezzi (1996) shows that supply constraints, regulations on cross-metropolitan variations, do impact properties' prices.[11] In addition, Chichernea, Miller, Fisher, Sklarz and White (2007) document a very strong relation between supply constraints and cap rates as well as evidence of capital flowing. They also define that cap rate can be used in various analysis methodologies to derive a property's likely resale price and current investment value.[12] I will describe more detail in the following chapters.

This preliminary research indicates the difference between two major indices, despite the different survey instrument, data source, and weighting focus. This thesis use regression analysis to compare different models and explains the difference between appraisal and transaction price within RCA CMBS data set.

[10] See Geltner and Pollakowski (2006), A Set of Indexes for Trading Commercial Real Estate Based on the Real Capital Analytics Transaction Prices Database.
[11] See Malpezzi (1996), Housing Prices, Externalities, and Regulation in U.S. Metropolitan Areas. And see Xing, Hartzell and Godschalk (2006), Land use Regulations and Housing Markets in large Metropolitan Areas.
[12] See Chichernea, Miller, Fisher, Sklarz and White (2007), A Cross Sectional Analysis of Cap Rates by MSA.

Chapter Two: Overview of CMBS Market and RCA Dataset

2.1 Overview of CMBS Market

2.1.1 CMBS Market

As opposed to residential real estate, Commercial Mortgage-Backed Security (CMBS) are bonds or other debt instruments secured by commercial real estate. CMBS issues are usually structured into multiple tranches ('tranche' in French is slice)[13], similar to CMOs. Commercial property means property let out or managed for economic benefit as opposed to that for self-occupation, and includes multi-family dwelling units (apartments or condominiums), retail centers, hotels, restaurants, hospitals, warehouses, and office buildings. In generic sense, CMBS also includes securitization of real estate leases.

Commercial real estate first mortgage debt is generally broken down into two basic categories: (1) loans to be securitized ("CMBS loans") and (2) portfolio loans. Portfolio loans are originated by a lender and held on its balance sheet through maturity. It is very difficult and impossible to allocate the transaction price of a portfolio to a individual property. Therefore, we will only test on those loans to be securitized in this thesis, not portfolio loans.

[13] Refer from Geltner & Miller (2006), Commercial Real Estate Analysis & Investments (2e), p490.

CMBS core property types are multifamily, retail, office, and industrial, and non-core products include credit-tenant leases, or CTLs, healthcare, and hotels.[14] This thesis extensively focuses on core property types, especially office and retail property type sectors due to the limits of transaction data.

Generally speaking, CMBS offers three primary benefits to investors, such as liquidity, external validation and structure. Due to the fact, CMBS is generally securitized as a secondary market for the shares. As known, outside rating agencies provide opinions on quality of the deal, which is helpful for investors to make decisions. Needless to say, CMBS has become an attractive capital source for commercial mortgage lending because the bonds backed by a pool of loans are generally worth more than the sum of the value of the whole loans. The enhanced liquidity and structure of CMBS attracts a broader range of investors to the commercial mortgage market. Therefore, borrowers can be benefited from this value creation effect, which allows loans intended for securitization to be aggressively priced.

2.1.2 CMBS History

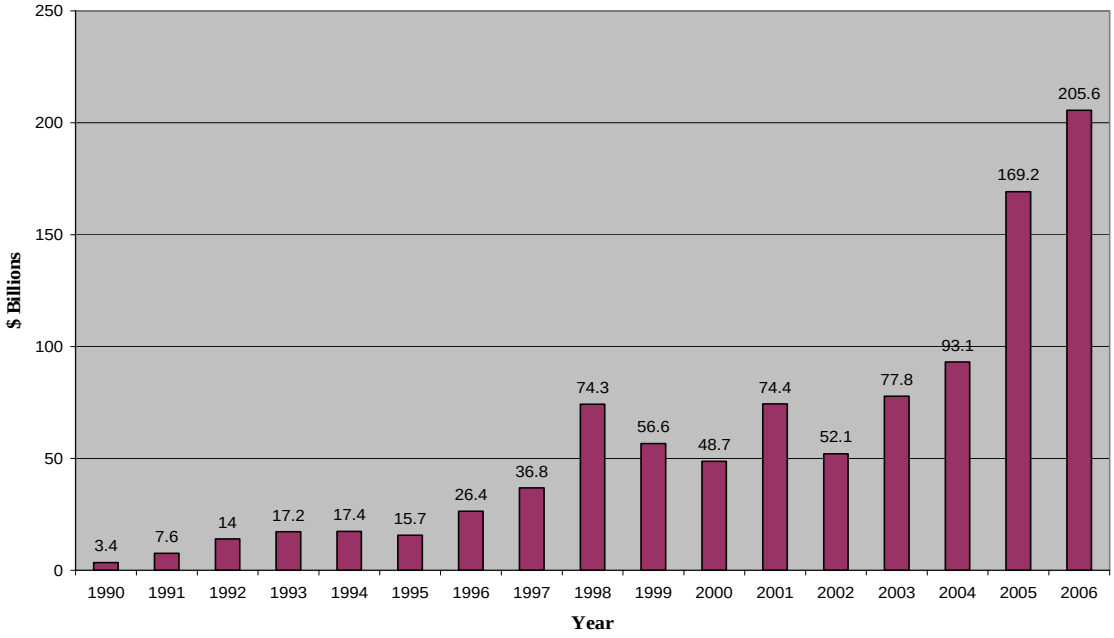
In the late 1980's and early 1990's CMBS began to be developed due to the need of the Resolution Trust Corporation (RTC) to liquidate large commercial mortgage holdings for the large-scale development of these instruments. While RTC clearly helped spur the development of the market, it is also clear that CMBS development was part of a larger trend in securitization.

[14] Quoted from Moody's –Lehman Brothers Study of Loss Severity in Defaulted CMBS Loans, *Moody's Investors Service Structured Finance Special Report November 22, 2004.*

The CMBS market grew unpredictably fast until 1998. From a volume of $6 billion in 1990, it reached $78.4 billion in 1998.[15] Most of the mortgage securitization was emerging from conduits - entities who would buy mortgage loans and securities them with arbitrage profits, which were available in plenty owing to the very fine spreads prevailing in the market. After terrorist attack in 2001, the CMBS market bounced back quickly and grew impressively since then[16], as illustrated in Exhibit 2-1. Exhibit 2-1 also shows that the dollar value of CMBS issued each year from 1990 to 2006.

Exhibit 2-1

CMBS Issuance U.S 1990-2006



Source: Commercial Mortgage Alert (2007)

2.2 Overview of RCA Dataset

2.2.1 RCA Dataset

[15] Data's source is from Commercial Mortgage Alert.
[16] Refer from Geltner & Miller (2006), Commercial Real Estate Analysis & Investments (2e), p492.

Real Capital Analytics (RCA), a national research and consulting firm headquartered in New York City, collects transactional information for current property sales and financings and analyzes and interpret the data. Their data covers all U.S. markets and focused exclusively on the investment market for commercial real estate.[17]

Overall, RCA provided data set includes 101,797 observations containing all related information in the United States since 2000 till the mid of 2007. Since 2001, RCA captured over $1.5 Trillion of sales and financings for significant office, industrial, retail, apartment and hotel properties nationwide. The minimum transaction price is $2.5 million.[18] Each transaction is meticulously organized, standardized and reviewed internally. More than 90% of the transactional records are complete with pricing, buyer, seller and property specifics.[19] In additional to those information, RCA data also contains other variables, including, but not limited to, property name, address, property types, building sizes, year built, occupancy rate, cap rate, number of floors, major tenants names, sale date, refinancing date, lender, loan amount, loan-to-value ratio loan interest, region, renovation for most properties. See *Appendix A* for detail information on the variables contained in the RCA data set.

Since this thesis focuses exclusively on the CMBS market, only 31,154 qualified observations left for analysis, which is about 30.6% of the whole database. Within CMBS data pool, it includes 3,530 observations (11.33%) that have been sold in the past, the rest of them are refinancing properties. See *Appendix A* for detail information. For those sold properties, they

[17] Quoted from Real Capital Analytics website at http:// www.rcanalytics.com.
[18] Refer from Real Capital Analytics website at http:// www.rcanalytics.com.
[19] Quoted from Real Capital Analytics website at http:// www.rcanalytics.com

include both transaction and appraisal prices if they are known. For those refinancing properties, RCA assume transaction price to be the same as appraisal value.[20]

2.2.2 CMBS Investors

The success of those early CMBS sales attracted a new group of issuers and, by 1993, a few investment banks set up origination networks, typically through mortgage bankers and securitized commercial loans. Other players worked with life companies and financial institutions that were trying to liquidate existing loan portfolios. Normally institutional fixed income securities investors buy public bonds and real estate high yield investors buy private bonds.

There are generally eight investors types included in the dataset from RCA, whose variable name is buyerinvcomp. They are 1) Private in state (local), 2) Private out of state (national), 3) Institutional, 4) REIT/Public/Fund, 5) Foreign, 6) User/Other, 7) Syndicator, 8) Condo Converter. Their detailed definition listed as below[21].

1). Private in State (local): includes private individuals, private investors, private developers and private trusts that operate within a small region of the country.

2). Private out of State (national): private firms, funds, individual investors with a super-regional or national investment reach and private Real Estate Investment Trusts.

[20] Quoted from a phone call with Glenn Day, a quantitative analyst at RCA, on June 20, 2007.
[21] This original definition is from Morrison's thesis (2006), An Analysis of Investor Type in Real Estate Capital Markets: Their Behavior and Performance from 2000 to 2006.

3). Institutional: comprised of various real estate funds that manage money on behalf of others, including endowments, pension funds, banks, finance companies, and insurance companies. They are not subject to taxes.

4). REIT/Public/Fund: includes publicly-traded REITs and Real Estate Operating Companies (REOC).

5). Foreign: those off-shore entities which invest in the United States.

6). User/Other: includes corporations, retailers, governments and other entities which use the real estate for business or entity operations. It also consists of other buyers and sellers not captured in another investor category.

7). Syndicator: includes Tenancy-in-Common (TIC) investment groups which are formed by many separate buyers to purchase real estate.

8). Condo Converter: those investors are an outgrowth of the "condo craze" that has manifested itself, common in apartment property type.

Appendix B shows detailed CMBS investor types in RCA data set.

2.2.3 CMBS Property Types

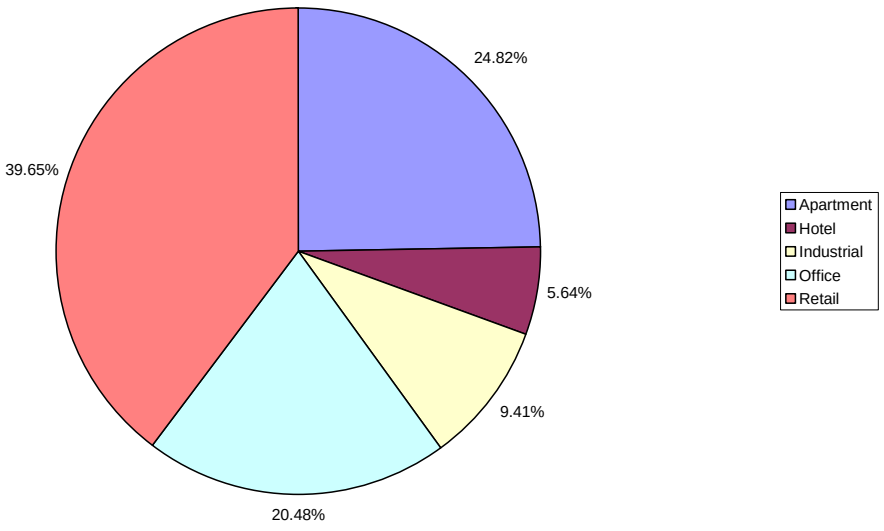
RCA CMBS data set contains five main property types (variable name is *main_type*), which are apartment, industrial, office, retail and hotel. Properties are grouped into one of these five categories, see Exhibit 2-2 for CMBS property types detail information. In each main type, it is also divided into 2 sub types (variable name is sub*type).* Apartment has garden and mid/high-rise types, which are differentiated by number of floors. If the property has lower than four floors, it

is in garden type, otherwise is mid/high-rise.[22] Industrial includes flex and warehouse. Office is divided by properties' location, either in CBD or suburb. Retail contains strips and mall & others. At last, hotel is divided into two types based on the service, like full service or limited service.

In CMBS market, retail leads the industry with 12,050 observations, followed by apartment and office, see Exhibit 2-2 for detail information. However, Exhibit 2-3 indicates that office and retail have almost the same amount of transactions.

Exhibit 2-2

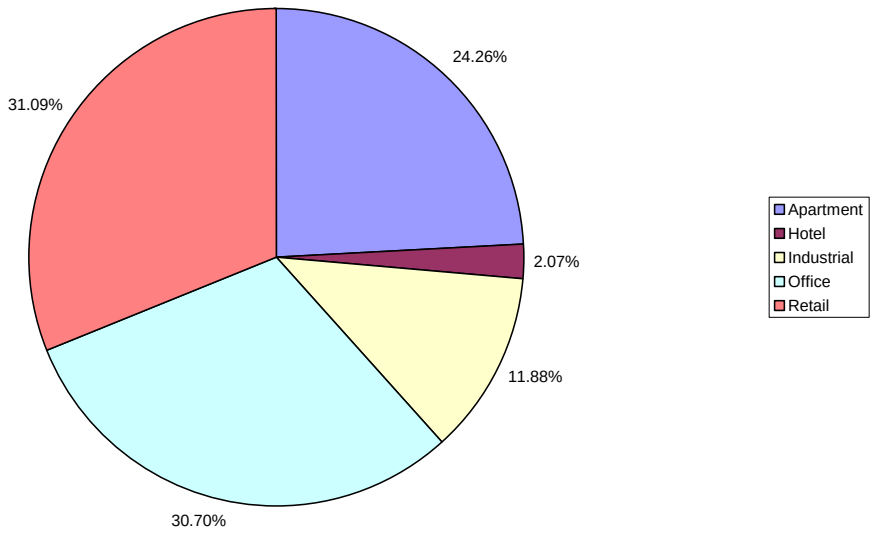
CMBS Property Types



[22] Quoted from a phone call with Glenn Day, a quantitative analyst at RCA, on June 20, 2007.

Exhibit 2-3

CMBS (Sale) Property Types



2.2.4 CMBS Property Regions

RCA has its own definition for region, for the purpose of consistence with other indices, I regrouped each properties into four regions based on NCREIF regions, including East, Midwest, south and West. Exhibit 2-4 shows properties allocation in each region. Exhibit 2-5 defines NCREIF regions. And *Appendix C* shows NCREIF region definitions.

Exhibit 2-4: Sale Region

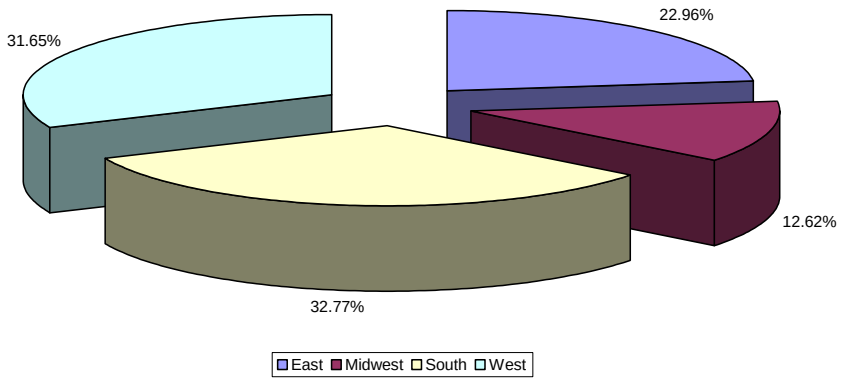
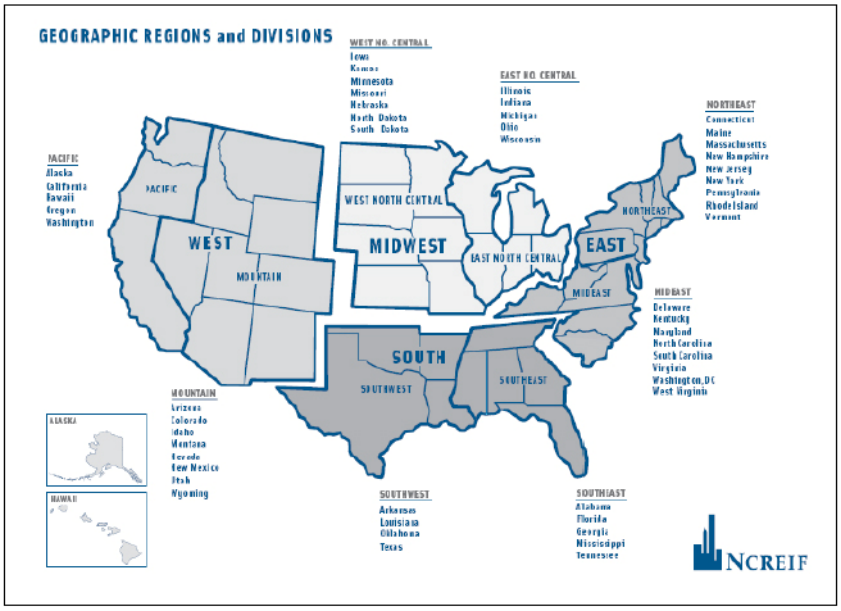


Exhibit 2-5: NCREIF Geographic Regions[23]



2.3 RCA Data Set limitations

Despite of wealth observations with detailed information from RCA, the data set poses certain limitations for further analysis. Firstly, they are limited by the time issue in light of the whole database only trace back to 2000, even though they do have numbers of observations back to 1998. As we know, real estate cycle is about ten years, meaning those data are not be able to cover one whole full cycle. In addition, the CMBS market established from 1990, it will be more convinced if the data set can cover from then. However, due to technology, it was not easy to collect information in the past like RCA does today.

[23] Refer from Gletner & Pollakowski (2006), A set of Indexes for Trading Commercial Real Estate Based on the Real Capital Analytics Transaction Prices Database, *pg21.*

Secondly, it still needs more important variables for hedonic regression analysis, information such as income and lease expiration. Those information are extremely important to determine the price of properties. Furthermore, lots of properties miss detailed information within provided variables, and thus I have to drop certain amount of properties in the hedonic regression model. Especially in the sale set of CMBS observations, the set itself is already relevant small, those missing information may cause bias in the final result.

Despite those above limitations, there are still possibilities and opportunities to establish valuable transaction and appraisal indexes with all meaningful observations.

Chapter Three: Methodology and Model Selection

In this chapter, I present the theoretical underpinning of my hypotheses by connecting them to models with various data sets. In addition, the first part of this section explains how each model has been defined and what my expectation is regarding the relationship among each variable in the later regression analysis.

3.1 Methodology

3.1.1 Introduction of Regression Analysis

To understand market behavior and simplify the compare price changes over time, accurate price indices are needed. Accurate price indices are able to be used as a method of valuing property, updating previous transaction price, helping with the rating of life insurance companies, calculating current market property's value and measuring investment performance. It is obvious that regression analysis is a time- and cost-effective supplement to the traditional sales comparison methodology for estimating the market value.

Today, Commercial Mortgage-Backed Security (CMBS) is in an important place of capital market. As known, the rating agencies, as well as the issuers and buyers of the lower-grade tranches, have an ongoing need to track property values. Annual property-by-property appraisals

are impractical, and thus regression analysis can be a better way to analyze ongoing value by using property characteristics, current sales and income at the property level.[24]

From the perspectives of investors, it's hard to compare the price difference between one to the other period. Besides the infrequent sale issue, random quality and quantity sale of properties in each period introduce more noise into the index. Over decades, in order to minimize random errors, academic real estate researchers have developed a few methodologies to construct a more sophisticated transaction-based index. Those methods are based on regression analysis. There are two approaches used broadly to construct the index better. Each method uses econometric regression methods to explain price levels or price changes and then uses the results to create an index of changes in price for a typical property.

Those two approaches are Hedonic Regression (HR) and Repeated Measures Regression (RMR) or Repeat-Sales Regression (RSR). An alternative to the hedonic-price estimation method is the "Repeated Measures Regression" (RMR) or "Repeat-Sales Regression" (RSR), which compares the value of a property to itself over time. This means that if we know what a property sold for in the past, and what it sold for recently, we can determine the change in value of the combination of characteristics that make up that property over time. RS model needs identified pairs of transactions to analysis, which HR model normally does not. Due to the sample size, this thesis will only use hedonic regression model as the tool of analysis.

[24] Refer from Crosson, Dannis & Thibodeau (1996), Regression Analysis: A Cost-Effective Approach for the Valuation of Commercial property Portfolios, *Real Estate Finance, Winter 1996: 12, 4; pg 21.*

However, none of those approaches is perfect. The HR price index has lots of spurious random volatility that causes more noise than other indices, plus it requires good data on numerous variables. RSR index is lacking data availability, which is most severe for the commercial real estate market. In addition, temporal aggregation is defined as the use of spot valuations of properties occurring over an interval of time to impute the spot value of a property or of a real estate value index as of a single point in time. Temporal aggregation may characterize not only appraisal-based indices but also indices based directly on transaction prices, such as regression-based indices like hedonic or repeat-sales indices.

3.1.2. Overview of Hedonic Regression

"Hedonic Regression" (HR) or called ccharacteristic method, is based on the hedonic value. In economics, hedonic regression is a method of estimating prices. It decomposes the item being researched into its constituent characteristics and obtains estimates of the value of each characteristic.[25]

The Hedonic method relies on the collection of comprehensive and reliable characteristic based information and makes the assumption that characteristics which aren't measured by the index don't affect value. Hedonic techniques are better suited to contend with index number problems per se, as they can accommodate changing attribute prices over time. They also appear to give rise to more reliable estimates of price indices, as unusual observations have less effect on estimated price indices. This model can re-estimate the model every period to produce an index of periodic returns, but it requires many transactions in each period to run the model. Needless to

[25] Refer from Http://www.wikipedia.org.

say, there is never enough data in the commercial real estate market because there are fewer transactions in commercial real estate than residential. Downs and Slade (1999) note that many states do not require sales price and transaction data to be disclosed in public[26], and thus lack of transaction data has hindered using this methodology in the past.

Despite the lack of data, an important problem encountered when using the hedonic-price method, which is not using a random sample of properties for the estimation. If the properties that transact are not representative of the entire stock of properties, then the standard econometric techniques may yield biased estimates of the coefficients in the hedonic model.[27] This may lead to a biased price index. In the past, several authors have found sample selection bias in their estimation based on their various researches, such as Gatzlaff and Haurin (1997, 1998) on residential properties, Jud and Winkler[28] (1999) and Munneke and Slade (2000) on office property. From those previous studies, I notice that selectivity bias plays a very important role in constructing constant-quality hedonic price indices. However, nobody is certain of market value of any given real estate asset at any given time. Thus, observations typically contain random "errors" and noise does exist in property price indices no matter how the index is constructed. More data we can get, less noise we will have.

[26] See Downs and Slade (1999), Characteristics of a Full-Disclosure, Transaction-based Index of Commercial Real Estate, *Journal of Real Estate Portfolio Management 5(1), pg 96.*
[27] See Munneke and Slade (2001), A Metropolitan Transaction-Based Commercial Price Index: A Time-Varying parameter Approach, *Real Estate Economics 2001 V29 1: pg 57.*
[28] See Jud & Winkler (1999), Price Indexes for Commercial and office properties: an application of the assessed value method, *Journal of Real Estate Portfolio Management, 591), pp 71-82.*

In the next section, I will explain how to use multivariate regression analysis to model the relationship between heterogeneous property characteristics and the market values of individual property based on RCA limited transaction data set.

3.1.3. Empirical Regression Methodology

Transaction-based regression analysis can be a useful tool to eliminate the temporal lag bias in appraisal–based indices. As described in 3.1.2, regression analysis is used to empirically quantify the hedonic value model (HVM), which views a property as a "bundle" of useful characteristics. A particular interest, on the left-hand-side of the equals sign, normally is referred as dependable variable. The value of the property[29] simply equals the sum of the values of each component in this bundle.[30] Those property characteristics are called hedonic variables (also called explanatory variables[31]), such as age, location, size and so forth. They measure cross-sectional differences in properties and estimate cross-time market value. Each hedonic variable is impacted by a value parameter or coefficient, giving the effect on market value per unit of the hedonic variable.[32] As Geltner & Pollakowski (2006) described, "The regression model is presented as an equation, with the dependent variable on the left-hand-side of the equals sign, and a sum of terms on the right-hand-side consisting of the explanatory variables each multiplied

[29] The value of property is often defined as the natural log of price.
[30] See Geltner, Miller, Clayton & Eichholtz (2006), Commercial Real Estate Analysis & Investments, *Appendix 25A: Real Estate Transactions Price Indices Based on Regression Analysis, pg11.*
[31] See Geltner & Pollakowski (2006), A set of Indexes for Trading Commercial Real Estate Based on the Real Capital Analytics Transaction Prices Database, *pg8.*
[32] See Geltner, Miller, Clayton & Eichholtz (2006), Commercial Real Estate Analysis & Investments, *Appendix 25A: Real Estate Transactions Price Indices Based on Regression Analysis, pg11.*

by a parameter whose value is estimated by hedonic regression and that relates each explanatory variable to the dependent variable".[33]

As a statistical procedure, regression analysis in commercial real estate market enables to explain relationship of dependent variable to each property variable. In this thesis, dependent variable is either appraisal value or transaction price depending on model types, which I will describe in the next section in details. Meanwhile, property characteristics that influence the dependable variable in each model are various due to model types and test objectives, listed later as well. However, most common hedonic variables inhere are NOI, the size of property, building age, location, property usage and number of tenants. A typical hedonic model specification in this thesis looks something like the following:

$$LnV = \alpha + \beta_1 \times LnNOI + \beta_2 \times Ln\ Sqft + \beta_3 \times Reno\_Dum + \beta_4 \times Age + \beta_5 \times cbd\_fg + \beta_6 \times MultiTenant + \beta_7 \times Malpezzi98 + \beta_8 \times Period\_j^{34} + \mu$$

where

α, β_i = the regression coefficients to be estimated[35]

LnV = either appraisal value or transaction price[36] (natural log[37])

LnNOI = annual property Net of Income (natural log)

LnSqft = Square feet of total building area (natural log)

Reno_Dum= dummy variable for renovation

[33] See Geltner & Pollakowski (2006), A Set of Indexes for Trading Commercial Real Estate Based on the Real Capital Analytics Transaction Prices Database, *pg 8.*

[34] Specifications are different depending on model type, check session 3.2 for clarifications.

[35] Represent the percentage price changes in each period.

[36] It depends on the model type, which is described in session 3.2.

[37] Logs are convenient to be used when the data fits in the estimation model.

Age = age of property at the time of appraisal or sale

Cbd_fg = dummy variable identifying property location (Central Business District or not)

MultiTenant= dummy variable for single or multitenant

Malpezzi98 = variable of supply constraint based on Malpezzi index (1998)[38]

Period_j = year-specific time dummy variables[39], j is from 2001 to 2006

μ = random noise associated with observation

Those dummy variables are binary, either 1 or 0. A dummy variable equal 1 means that properties have the particular characteristic otherwise equal 0. Those coefficients can be positive or negative, interpreted as premiums or discounts to variables. As seen from above, commercial hedonic models are not compared with more detailed residential. In addition, we're limited to work with fewer transaction observations.

The period frequency in a hedonic model can be measured in years, quarters or months. Our initial was to construct quarterly indices, but one underlying problem in quarterly measurement is lack of transaction data, which caused significant noises and random errors in the results. Normally, in order to achieve significant results using quarterly periods, there should be at least 500 or more observations in the sample. Therefore, I chose yearly as the period frequency to have reasonably accurate results.

The market value of an income property is the present value of expected future benefits discounted at the market discount rate. Normally, we need to approach income capitalization,

[38] The data is emailed from Prof. Malpezzi on June 13, 2007.
[39] The reason to choose yearly as the period frequency is described on page 33.

sales comparison or cost to estimate market value. Because NOI captures most of the expected future benefits associated with current ownership, NOI determine the property price significantly. In particular, NOI measures the price and price is influenced by property characteristics. Thus, the change or difference of building characters yield the change of NOI, then NOI affects sale price movement. Clearly, the regression analysis result should indicate that NOI is the primary factor to determine price.

In most models, I use NOI equal debt service coverage ratio (DSCR)[40] multiple loan amount (total debt service) in order to get income. This method is a backward looking way to estimate market value. As we know, a DSCR of less than 1 means a negative cash flow.

Even though NOI explains most of the variation in market values, other property characteristics have more or less influence on price. The reason for this is that they affect certain risks associated with income investments.[41] For example, building age influents price, because uncertainty of building condition can be affected in the expected cash flows if the property is too old. More likely, older buildings require extra maintenance expenditure or repair fee in the near future. Thus, those extra dollar amount are added to NOI calculation and reduce sell price.

From Price is equal to NOI divided by cap rate, we can conclude that any property that has potential to lower the cap rate will increase the market value. Briefly, less risk to reduce cap rate will lead higher sale price. Therefore, characteristics of those properties may influence the risk of

[40] DSCR = NOI / Total Debt Service.
[41] Refer Crosson, Dannis & Thibodeau (1996), Regression Analysis: A Cost-Effective Approach for the Valuation of Commercial property Portfolios, *Real Estate Finance, Winter 1996: 12, 4; pg 21-22.*

commercial property investments, such as property locations. In particular, properties located in CBD areas have higher market value compared with suburban properties.

However, those hedonic variables may act differently in different property types and regions. But this analysis overall allows the coefficients on the time dummy variables to capture the price effects, and thus to obtain the time variation in market value.

Furthermore, this analysis provides an opportunity to compare the difference between appraisal value and transaction price for the same observations at the same period. In addition, appraisal behavior does contribute to the constant quality aspects of a transaction-based index.[42]

3.2 Data Filters and Model Selection

The objective of this thesis is to test what kinds of property characteristics influence sale price (further market value) in a cross-time function, to compare appraisal value and transaction price in different periods, and to capture time variation in value in various property types.

3.2.1 Data Filters

As mentioned in section 2.2.1, RCA data set has about 31,154 observations in CMBS market, which is about 30.6% of total RCA data set. However, not all of them are qualified our regression model criteria. The quality of the empirical data is very important for constructing a reliable price index. In those observations, there are only 3,530 properties with transaction, about

[42] Result will be emphasized on Chap 4.

11.33% in the CMBS market. After reviewing all CMBS data set, I set up a few rules to clean unqualified observations out. These filter rules are listed in details below.

1). Portfolio Transactions:

I eliminated those either "mixed" or "portfolio" properties, because it is difficult to assign accurate price to each property by estimating portfolio property. Briefly to explain, if an observation is composed of numerous properties, whose holding periods vary individually, this sample will cause noise and uncertainty in the regression result.

2). Data time frame:

All properties with transactions or appraisals either before 2001 or after 2006 are dropped.

3). Incomplete information:

Observations without full information on any characteristic for regression analysis are excluded.

4). Built time before appraisal or sale time:

Properties that are built after appraisal or sale time are discarded, because their prices are most likely to be the land value, which is not relevant to this thesis.

5). Extreme difference between sale and appraisal date:

Some deals have second appraisal occurred 30~60 days after the sale agreement[43], therefore, those properties with more than 90 days difference between sale time and appraisal time[44] are dropped.

[43] Quoted from meeting with Bob White, the president of Real Capital Analytics (RCA), on July 12, 2007.
[44] Difference dates = Sale date – Appraisal date

Exhibit 3-1: Difference between Sale Date and Appraisal Date

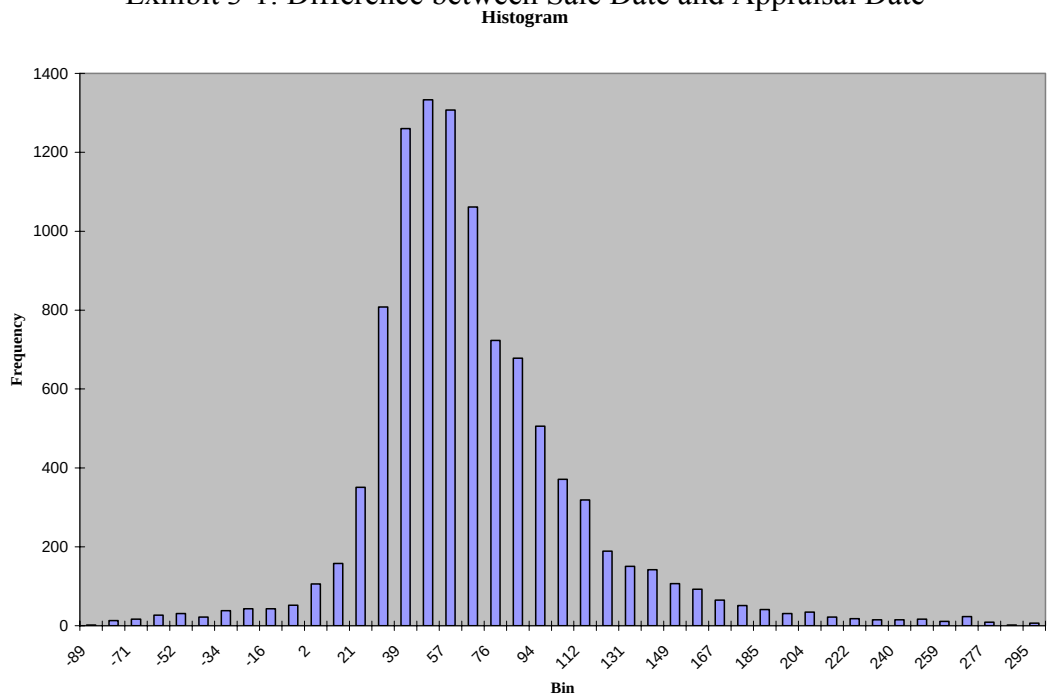


Exhibit 3-1 shows the frequency of difference dates between sale date and appraisal date. Most properties are sold 30-90 days after appraisal. A negative number depicts that the appraisals occur after transactions.

6). Extreme building size:

Properties with either less than 1,000 square feet or more than 3,500,000 square feet are eliminated.

7). Cap rate range:

A property is not included in the index if its cap rate is lower than 3.5% or higher than 12%.[45]

The objective of setting up those filters is to remove those inappropriate data that will not reflect price changes in the CMBS market. I believe those filters will help to contribute accurate data

[45] The definition is based on Real Capital Analytics (RCA) Capital Trends Monthly report of May 2007.

and to improve the quality of the index. As noted, those rules are used to be standards in most index construction, respectively.

3.2.2 Model Selection

To demonstrate the practical application of regression analysis, I first defined RCA data set into four different categories based on transaction appearance. Only the first model tests refinancing market and the rest of three models basically estimate sale market. Those four models are defined as below:

Model 1 (M1): Appraisals exclude transactions; those properties are only refinanced without sale process. In this model, appraisal value is put on the left side of the specification in order to examine the influence from relevant property characteristics. (Refinancing)

Model 2 (M2): To test transaction prices in sale market, including those observations that the ratio of appraisal and transaction price equal 1. Transaction price is put on the left side of hedonic regression specification to see those related variables' impact. (Sale)

Model 3(M3): To test appraisal value in sale market, excluding those observations that the ratio of appraisal value and transaction price equal 1. Appraisal price is put on the left side of this specification to see those related variables' impact. In addition, I use two different ways[46] to calculate NOI in this model to examine the difference.(Sale)

[46] The two different ways are forward looking and backward looking, which are described in Chapter 4 in details.

Model 4 (M4): To test transaction prices in sale market, excluding those observations that the ratio of appraisal value and transaction price equal 1. Transaction price is put on the left side of hedonic regression specification to compare with model 3. (Sale)

As you can see, model 1 has the most observations among all four models, followed by model 2. Model 3 and 4 have the exactly same amount of observations, and thus it's convenient and clear to compare the difference between appraisal value and transaction price. In particular, model 1 and 3 test appraisal value and model 2 and 4 estimate transaction price. For those four models, I analysis mostly the same hedonic variables, but I use a couple of different dummy variables to fit its own criteria and to get better results.

After cleaning the whole data set by Stata, there are 16,366 observations left in CMBS market, including 8,539 qualified observations left for model 1, 1,262 observations for model 2, 989 observations for model 3 and 4. As noted, 273 properties have the same transaction price as appraisal, which occupies 21.6% of total sale sample size.

Because sample size of both apartment and industrial properties are very small after data filtering, the index series captured significant noise for both types. Therefore, both types have been eliminated from regression analysis. Exhibit 3-2 shows that total amount of observations in each model.

Exhibit 3-2: Regression Models Sample Size

Observations	Model 1	Model 2	Model 3&4
Office	2331	385	309
Retail	5107	505	382
Others	1101	372	298
Total	8539	1262	989

For the purpose of this study, Exhibit 3-3 to Exhibit 3-5 illustrate how property types distributed over each model.

Exhibit 3-3: Model 1 property type distribution

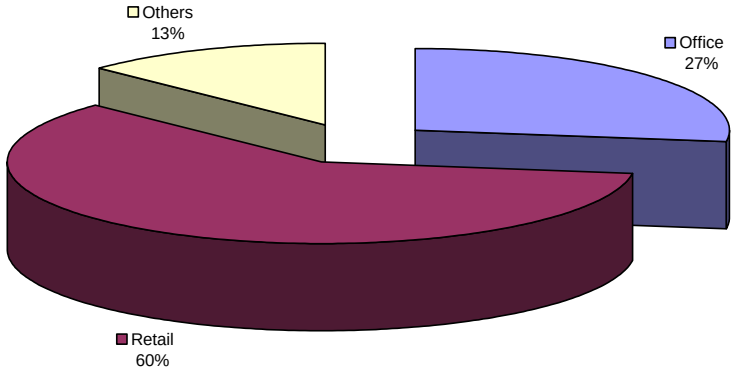


Exhibit 3-4: Model 2 property type distribution

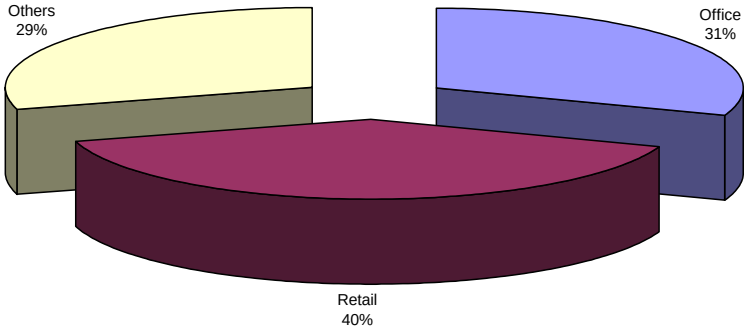
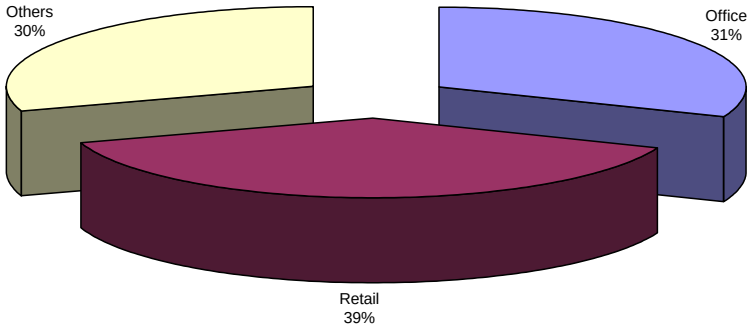


Exhibit 3-5: Model 3 & 4 property types distribution



By looking at those sample composition, I find that existence of potential bias may occur while examining those sale (transacting) and refinancing (non-transacting) properties. If the two models (M1 & M2) are significantly different, reliability of a price index derived from the sold model (M2) may not accurately reflect the price movement in the population of the property.[47] As mentioned earlier[48], sold sample (M2) is much smaller than refinancing sample size, however, it has a higher mean square footage, a lower mean occupancy rate and cap rate when compared with refinancing model (M1). According to Munneke and Slade (2000), these results may tell us that transaction-based indices suffer from selectivity bias due to the limited transaction data. As RCA data base for this study continues to grow in the near future, I am sure the expansion of number of qualified observations will allow more precise adjustments and accurate results.

[47] See Munneke & Slade (2000), An Empirical Study of Sample-Selection Bias in Indices of Commercial Real Estate, *Journal of Real Estate Finance and Economics; Jul 2000: 21, 1: pg 45.*
[48] Refer to page 39 for clear definition.

Chapter Four: Analysis and Results

This chapter presents developed price indexes based on the RCA transactions prices database, using the Hedonic Regression, a methodology introduced and described in chapter 3. Since those objectives and criteria to set up those sets of indexes have been noted in last chapter, I will more focus on representing and summarizing conclusion of analysis results in this chapter. Again, the goal of this thesis is to examine the difference between transaction price and appraisal value in the U.S. CMBS market for the purpose of tracking the trends, valuing the market for investors, or supporting future commercial real estate derivative products.[49]

As noted, the indexes cover from the beginning of 2001 to the end of 2006, the period that has been one of the best in the history of U. S. property market. Basically, the set of indexes traced the "bull market" of commercial real estate. As mentioned in chapter 2, CMBS market grew impressively since 2001[50], about $205.6 Billion issued in 2006, and it continues growing in 2007.

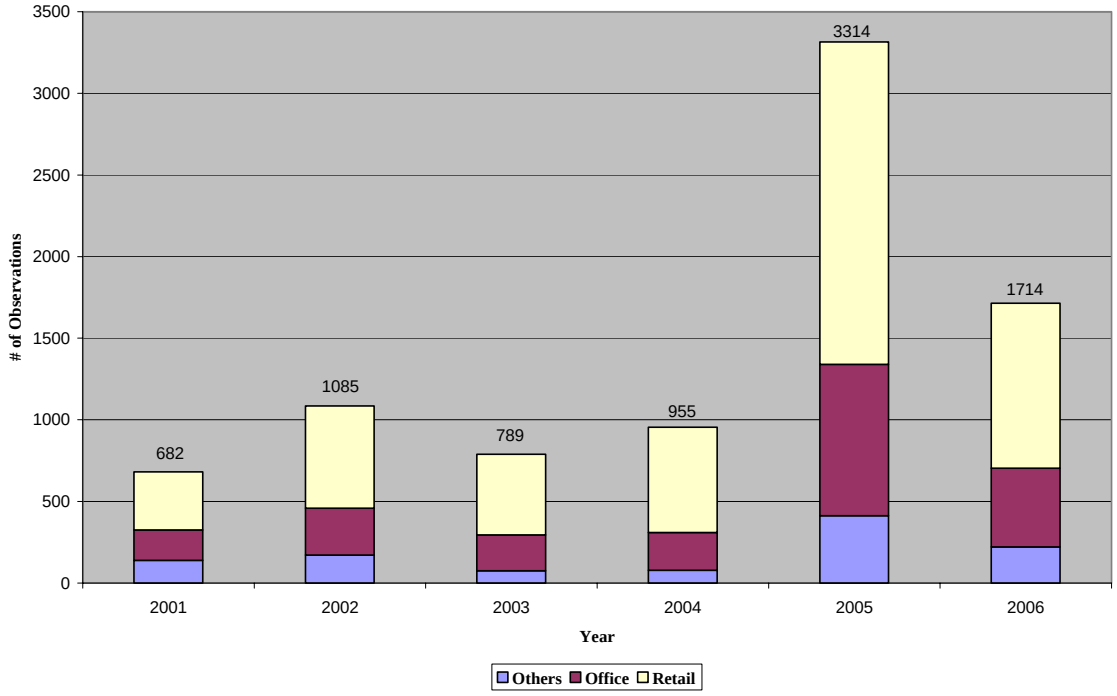
4.1 Sample Size of Each Model

Due to the limit of transaction data, this thesis only estimate on national property level, fully focuses on office and retail with minor concentration on apartment and industrial. To reduce random error, the frequency of a set of indexes is annually for all property types. Exhibit 4-1 presents the sample size in each model distributed by property types. All of the actual numbers of observations are presented in Appendix D.

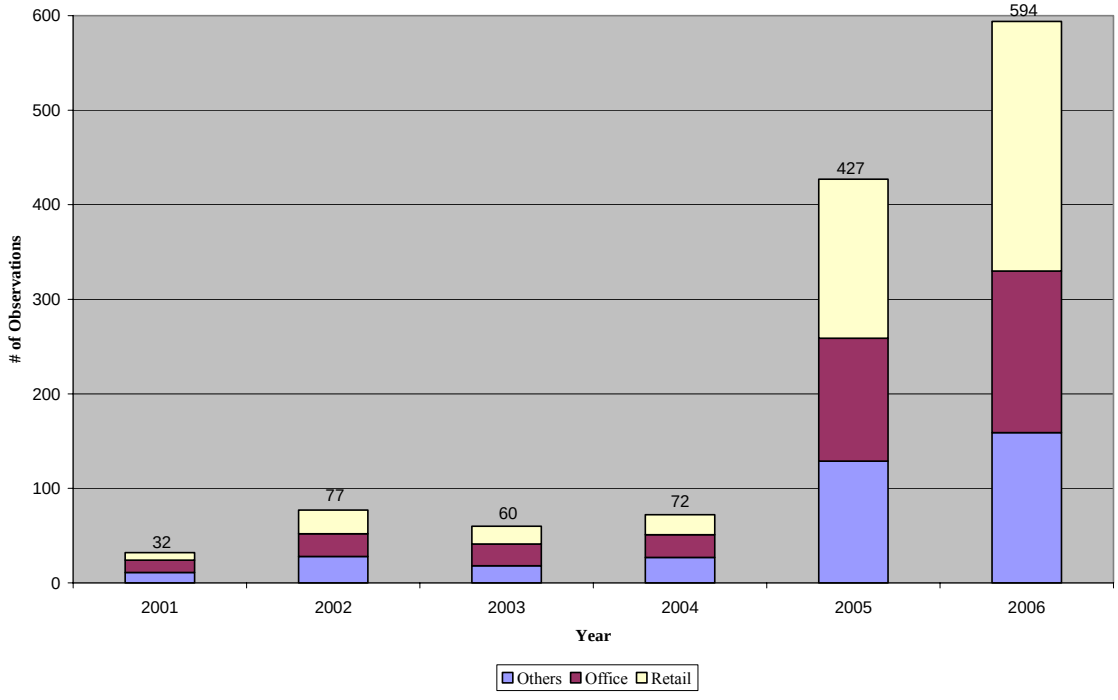
[49] Projected at Morgan Stanley US CMBS report, Commercial Property Return Indexes: Choosing From the Menu, *February 20, 2007.*
[50] Check Exhibit 2-1 for CMBS issuance 1990-2006 for more details.

Exhibit 4-1 Models Sample Size

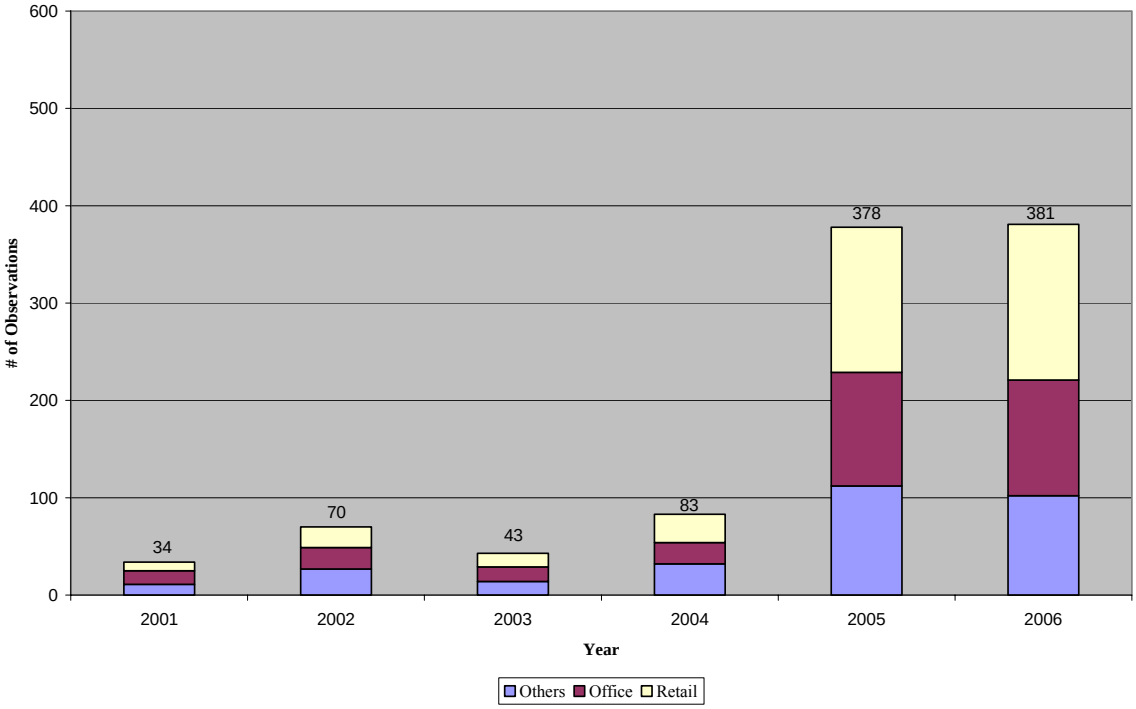
Model 1: Sample Size Distribution



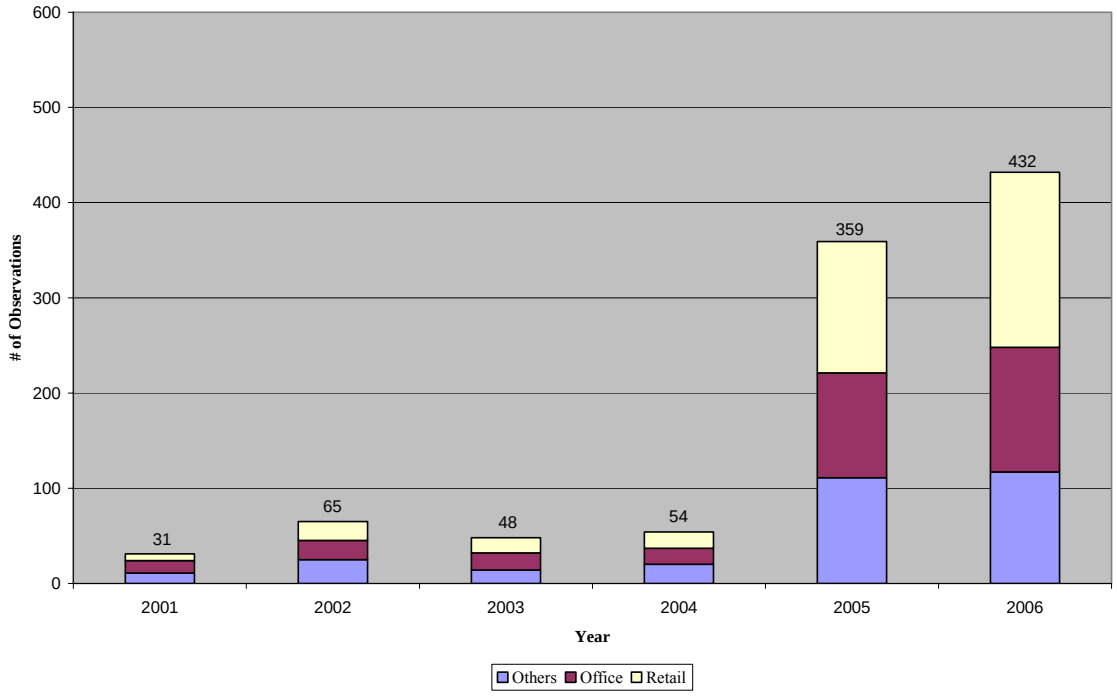
Model 2: Sample Size Distribution



Model 3: Sample Size Distribution



Model 4: Sample Size Distributioin



* Chart of Model 1 scale is slightly different with other models.

As noted in above charts, retail transaction volume is much higher than any other property types in refinancing of CMBS market, but almost equally split the sale market. For all the property types, CMBS market bounced up after 2001 terrorist attack, and dropped slightly on the following years (2003 and 2004), consistent with CMBS issuance volume.[51]Since RCA database only began coverage in 2000, it's hard to compare with previous years along with CMBS historical data. As is apparent in Exhibit 4-1, the year 2005 was an exceptionally strong year, especially in CMBS refinancing market. Due to the national economy recovery with heated demand for portfolio and steep declined cap rate, the year 2005 hit the record, followed by the year 2006. In addition, there are more refinancing occurred in 2005, but more transactions going on in the following year.

4.2 Descriptive Statistics of the data set

A summary of the descriptive statistics of each model is presented in Exhibit 4-2. As described in Chapter 3, the dependent variables on model 1 and 3 are appraisal value, and on model 2 and 4 are sale price. Therefore, there are only appraisal value on Model 1 and 3, and sale price on model 2 and 4. In model 1, the mean appraisal value is $19,620,949 and the building size is 108, 961 square feet within 8,539 observations. A mean building age of 20 years in all four models suggests that most of the properties are newer. This is consistent with the significant growth in commercial real estate and increase in CMBS issuance volume. With this in mind, all of these numbers are cross national for all property type sectors. Appendix E summarizes descriptive statistics of all four models together.

[51] Refer to Chapter 2 Exhibit 2-1.

Exhibit 4-2

Exhibit 4-2-1. Model 1: Sample Descriptive Statistics (N=8539)

	Stats.	App. Value	Cap Rate	NOI_Bwd[52]	Sqft	App. Age	Malpezzi98
Model 1	Mean	$ 19,620,949	7.56%	$ 109,746	108,961	19.92	21.78514
	Std. Dev.	$ 60,353,973	1.12%	$ 234,682	173,234	21.69	2.796102
	Min.	$ 2,500,000	3.59%	$ 9,156	1,100	1.00	17.05
	Max.	$ 1,850,000,000	11.96%	$ 5,299,840	2,941,646	224.00	28.692

Exhibit 4-2-2. Model 2: Sample Descriptive Statistics (N=1262)

	Stats.	Price	Cap Rate	NOI_Bwd	Sqft	App. Age	Malpezzi98
Model 2	Mean	$ 23,116,318	7.17%	$ 113,744	145,852	19.18	21.24146
	Std. Dev.	$ 74,084,882	1.05%	$ 190,165	204,963	18.20	2.762909
	Min.	$ 2,500,000	3.74%	$ 13,239	4,701	1.00	17.05
	Max.	$ 1,720,000,000	11.50%	$ 2,415,891	2,840,000	157.00	28.692

Exhibit 4-2-3. Model 3: Sample Descriptive Statistics (N=989)

	Stats.	Appr. Value	Cap Rate	NOI_fwd[53]	NOI_Bwd	Sqft	App. Age	Malpezzi98
Model3	Mean	$ 24,196,340	7.22%	$ 1,544,965	$ 117,620	150,430	19.59	21.20449
	Std. Dev.	$ 74,442,605	1.06%	$ 3,727,752	$ 187,509	194,476	18.41	2.720619
	Min.	$ 2,565,000	3.74%	$ 160,446	$ 13,239	4,701	1.00	17.05
	Max.	$ 1,850,000,000	11.50%	$ 78,088,000	$ 2,415,891	2,840,000	157.00	28.692

Exhibit 4-2-4. Model 4: Sample Descriptive Statistics (N=989)

	Stats.	Price	Cap Rate	NOI_Bwd	Sqft	App. Age	Malpezzi98
Model 4	Mean	$ 22,936,101	7.22%	$ 117,620	150,430	19.69	21.20449
	Std. Dev.	$ 69,106,851	1.06%	$ 187,509	194,476	18.41	2.720619
	Min.	$ 2,500,000	3.74%	$ 13,239	4,701	1.00	17.05
	Max.	$ 1,720,000,000	11.50%	$ 2,415,891	2,840,000	157.00	28.692

[52] NOI_Bwd stands for backward looking NOI, using NOI = DSCR x Loan. Also refer to Chapter 3 page 34.
[53] Amount NOI_fwd stands for forward looking NOI, using NOI = Cap Rate x Price.

As noted on the statistics, NOI has significant difference using different way to calculate in models 3, detailed conclusion will be drawn in the later section. Comparing model 3 with model 4, for the same properties, the mean appraisal value is much higher than the mean sale price. This unanticipated result is analyzed below.

Here I specifically examine the statistical contribution of refinancing and sales information that are unique to the database, and contrast the transaction-based index to the appraisal-based index in the next section.

4.3 Analysis of Indexes

Appendix F reveals the full results of model 1-4 indexes. As noted, nearly all of the coefficients are consistent with my expectations. In that regard, a majority of the hedonic variables are significant at the .1 level, the .50 or above coefficient suggests a sign of determination. A positive coefficient of hedonic variable means a premium to the dependable variable, which means the value parameters have a positive relationship with either sale price or appraisal, otherwise a discount to the dependable variable.[54] In this section, I will explain those results model after model in details. In the next section, a comprehensive comparison among or between models will be drawn.

[54] Refer from Geltner, Miller, Clayton & Eichholtz (2006), Commercial Real Estate Analysis & Investments, *Appendix 25A: Real Estate Transactions Price Indices Based on Regression Analysis, pg11.*

4.3.1 Analysis of National Refinancing Indexes (Model 1)

Exhibit 4-3 shows the annual appraisal-based National All-Property Index, National Office Index and National Retail Index from 2001 to 2006. The comparison indicates that Retail Index has a slightly higher capital appreciation than All-Property Index and Office Index. This difference is probably due at least in part to the lag since the set of indexes are appraisal based[55]. As noted in the chart, retail index shows sign of leveling down in 2006, which is not consistent with the sustained upward movement of All-Property Index. Office Index follows the same movement as All-Property Index. Generally speaking, both property type sectors have broadly moved together and have shared in the great bull market.

Exhibit 4-3

Model 1: Appriasials w/o Transactions (Refinancing)

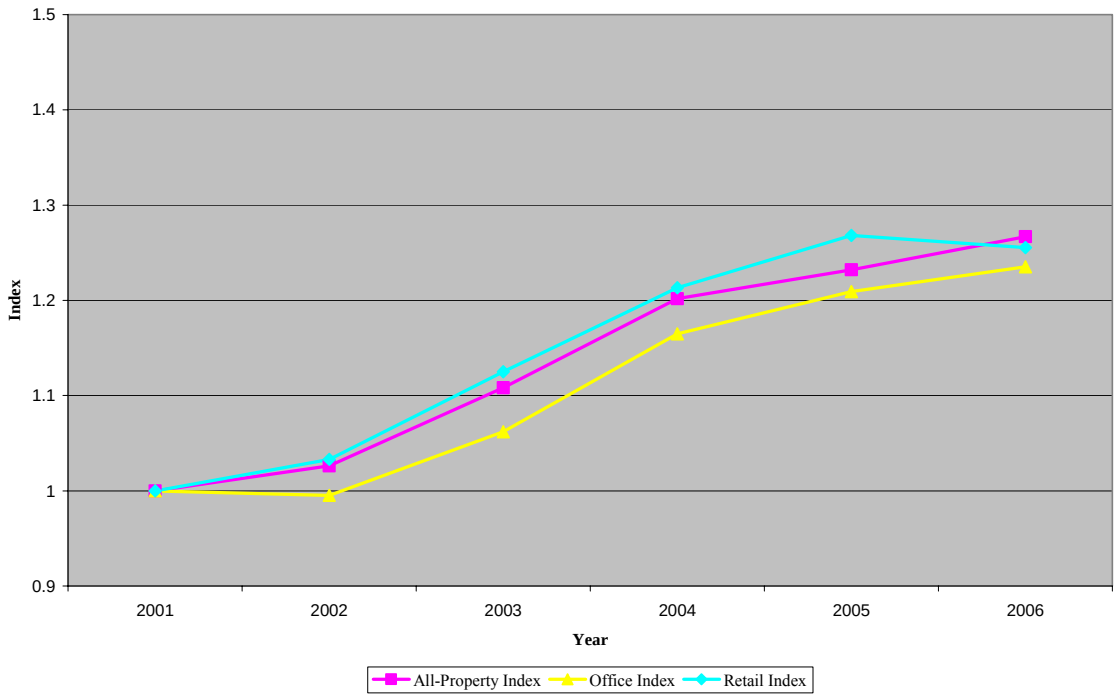


Exhibit 4-4 presents the result of model 1 hedonic regression analysis. Most coefficients support my expectation described in Chapter 3. With a high range of 0.62-0.88, NOI determines

[55] There is no transaction in this regression model.

property's appraisal value significantly. Comparing with Office Index, Retail Index is influenced by NOI more. Building size and location are important variables and both exhibit positive coefficients in all three Indexes, consistent with my expectations. Bigger building and CBD locations always allure more buyers with higher market value. Renovation is significant for All-Property Index, but not for Office and Retail. The reason behind is that most properties tracked by RCA are relatively new (mean age is 20 years). Compared with appraisal age 0 to 5, all other ages variables have negative points, which suggest that older properties sell or appraised at a relative discount value. It's clear that older properties depreciate values more among all three indexes, and appraised age plays a significant role in the regression as well. As noted, the number of tenants only significantly affected office property value, not for other type sectors, which is easy to understand. Not surprisingly, supply constraint is significant at the 0.01 level, because systematically low approval rates indicate generally restrictive views toward further development, then increase property price respectively.

Comparing with industrial in All-Property Index, retail and office property types are appraised higher than industrial; the result for apartments is not statistically significant, probably due to the lower sample size for apartments.

Since RCA started to cover the market in 2000, I cannot compare my result with last decade. However, the results of the indexes follow the experience of commercial real estate market from 2001 to 2006 in the United States. The market was bottomed out in approximately 2001, then was picked up after 2002 slowly, and was perceived to have peaked in 2005 and 2006. Positive coefficients of year variables suggest that prices have gone up, the total incline in prices during

2001-2006 is approximately 21%. This provides clear provide evidence of a market booming, consistent with the market.

Exhibit 4-4 Regression Result of Model 1: Appraisals w/o Transactions (Refinancing)

Hedonic Variables	All Property	Office	Retail
COEFFICIENT	LnAppraisal	LnAppraisal	LnAppraisal
LnNOI_Bwd	0.738*** [0.0057]	0.621*** [0.012]	0.882*** [0.0064]
LnSqft	0.213*** [0.0054]	0.373*** [0.013]	0.0967*** [0.0060]
Reno_Dum	0.0169** [0.0078]	0.0204 [0.014]	-0.0027 [0.0085]
AppAge5to10	-0.0535*** [0.010]	-0.0826*** [0.021]	-0.0103 [0.010]
AppAge10to30	-0.0946*** [0.0083]	-0.0986*** [0.016]	-0.0463*** [0.0089]
AppAge30to50	-0.107*** [0.012]	-0.0908*** [0.022]	-0.0569*** [0.013]
AppAgeGreaterThan50	-0.0776*** [0.015]	-0.151*** [0.025]	0.0355* [0.018]
cbd_fg	0.156*** [0.012]	0.165*** [0.018]	0.0663*** [0.016]
MultiTenant	-0.0123 [0.0081]	-0.0413** [0.017]	-0.0126 [0.0085]
Malpezzi98	0.0265*** [0.0011]	0.0344*** [0.0020]	0.0149*** [0.0012]
Apt_Dum	0.387 [0.27]		
Ret_Dum	0.296*** [0.010]		
Off_Dum	0.272*** [0.011]		
Period_2002	0.0258* [0.013]	-0.00473 [0.024]	0.0324** [0.014]
Period_2003	0.103*** [0.014]	0.0602** [0.026]	0.118*** [0.015]
Period_2004	0.184*** [0.014]	0.153*** [0.025]	0.193*** [0.014]
Period_2005	0.209*** [0.012]	0.190*** [0.021]	0.238*** [0.013]
Period_2006	0.237*** [0.014]	0.211*** [0.027]	0.227*** [0.015]
Constant	4.704*** [0.045]	4.373*** [0.083]	4.903*** [0.046]
Observations	8539	2331	5107
R-squared	0.92	0.94	0.94

Standard errors in brackets
*** p<0.01, ** p<0.05, * p<0.1

4.3.2 Analysis of National Sale Transaction Indexes (Model 2)

Exhibit 4-5

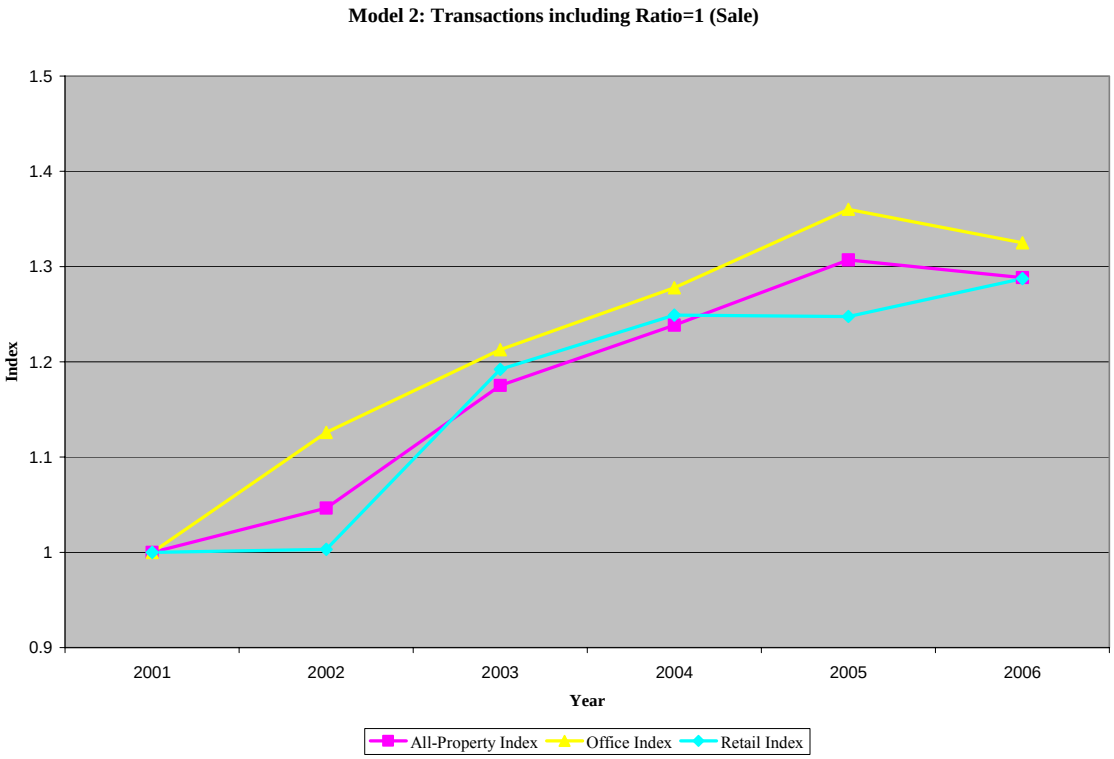
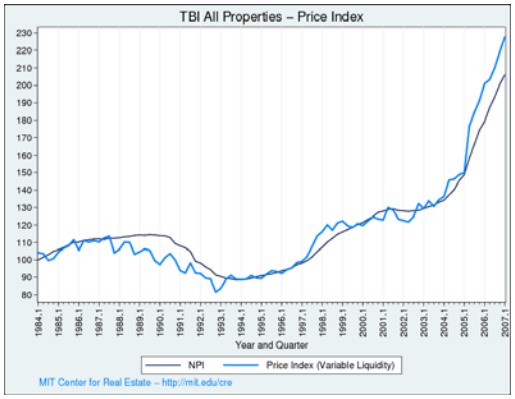


Exhibit 4-5 shows the annual transaction-based National All-Property Index, National Office Index and National Retail Index from 2001 to 2006. Not like appraisal indexes shown in model 1, office sale price is much higher than other property types in each year even though Office Index follows the same movement as All-Property Index. After technology bubble and 9-11 attack, office market started recovery since 2002. Due to the supply falling, job growth and strong corporate balance sheets, national level office market improvement has been witnessed since 2004. According to RREEF report (July 2006), national office availability fell from 15.3% to 13.6% in 2005, while almost 90 million square feet space was absorbed.[56] Therefore, the index is consistent with the market. Retail markets have been exceedingly strong in the past years. Sales

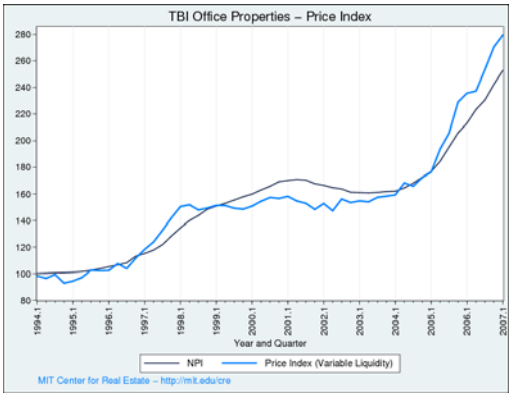
[56] RREEF Research (July 2006): US Office Market – Keep Riding the Cycle, *Number48, page 1.*

growth slowed during the recession in 2001 but bounced back quickly in 2004[57]. Retail Index clearly reflects the market trends. However, even though the retail market continued growing in 2005, the Retail Index shows a slight decline at the same period.

Exhibit 4-6 TBI Indexes



However, all-property and office index shows decline between 2005 and 2006, and retail indicate a climb at the same period. Relatively comparing with TBI price indexes (see Exhibit 4-6), both all-property and office indexes show increase during that period.



The estimated parameters for models 2 are provided in Exhibit 4-7. As previous, the first column shows all variables names, the second one reports coefficients for All-Property Index, followed by Office Index and Retail Index. As noted, the coefficient of NOI is in the 0.90 – 0.97 range in all indexes, which indicates that NOI is clearly the most important determinant of property value. In addition, property age, size, location, institution buyer and supply constrain also explain some of the variations in sales price. However, property age is not a significant characteristic for office sector. In major US office market, many CBD office buildings are older than fifty years, and thus they often become

[57] RREEF Research (July 2006): US Retail Market – Investment Opportunities at the Peak of the Market, *Number50, page 1.*

iconic architectural images.[58] It is interesting to see that number of tenants does not affect office sale price.

Exhibit 4-7 Regression Result of Model 2: Transaction including Ratio =1 (Sale)

Hedonic Variables	All Property	Office	Retail
COEFFICIENT	LnPrice	LnPrice	LnPrice
LnNOI_Bwd	0.960*** [0.014]	0.899*** [0.031]	0.971*** [0.020]
LnSqft	0.0377*** [0.012]	0.143*** [0.033]	0.00967 [0.018]
Reno_Dum	-0.00301 [0.014]	-0.0272 [0.027]	0.00437 [0.022]
Age5to10	-0.0437** [0.019]	-0.0664 [0.045]	-0.0396 [0.025]
Age10to30	-0.0760*** [0.017]	-0.0896** [0.039]	-0.0880*** [0.023]
Age30to50	-0.0882*** [0.023]	-0.066 [0.052]	-0.0632* [0.036]
AgeGreaterThan50	-0.130*** [0.036]	-0.120* [0.067]	-0.0668 [0.056]
cbd_fg	0.106*** [0.024]	0.0615 [0.039]	0.0857* [0.048]
MultiTenant	0.0264** [0.013]	-0.0048 [0.024]	0.0379** [0.019]
Malpezzi98	0.0121*** [0.0023]	0.0205*** [0.0045]	0.00556 [0.0035]
InstlBuyer	0.0941*** [0.020]	0.113*** [0.033]	0.065 [0.047]
Apt_Dum	0.0763*** [0.021]		
Ret_Dum	0.0585*** [0.022]		
Off_Dum	0.0617*** [0.021]		
Period_2002	0.0455 [0.042]	0.119 [0.077]	0.00315 [0.075]
Period_2003	0.161*** [0.043]	0.193** [0.078]	0.176** [0.078]
Period_2004	0.214*** [0.042]	0.245*** [0.077]	0.222*** [0.077]
Period_2005	0.268*** [0.037]	0.308*** [0.065]	0.221*** [0.068]
Period_2006	0.253*** [0.036]	0.281*** [0.064]	0.253*** [0.067]
Constant	4.664*** [0.10]	4.015*** [0.21]	5.047*** [0.16]
Observations	1262	385	505
R-squared	0.96	0.96	0.95

Standard errors in brackets
*** p<0.01, ** p<0.05, * p<0.1

[58] According to Bob White, president of RCA, meeting on July 12, 2007.

In this model, comparing with industrial, all other property types are very significant regarding the market value for all properties, especially apartment sector, which is opposite with model 1. The rest results are consistent with model 1 and my expectation, following the market trends.

4.3.3 Analysis of National Sale Appraisal excluding Ratio=1 Indexes (Model 3)

Exhibit 4-8

Model 3 -1: Appraisals w/Transactions excluding Ratio=1 (Sale -Forward looking)

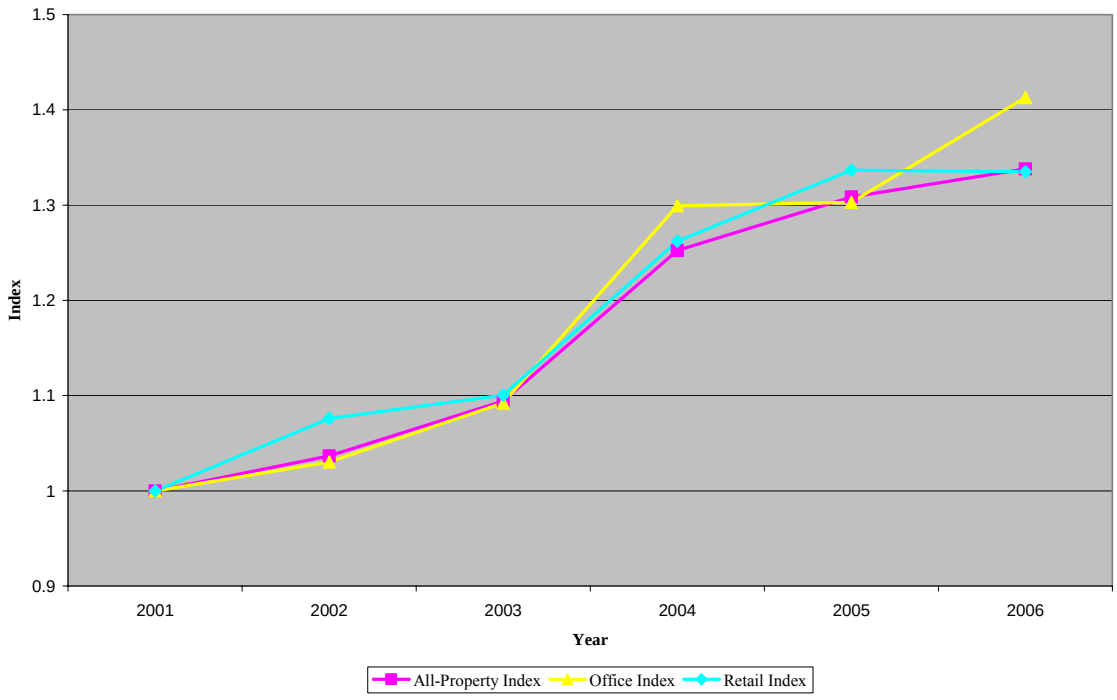


Exhibit 4-8 and 4-9 presents the results of annual appraisal All-Property Index, Office Index and Retail Index. For the purpose of examining appraiser behavior, I used two different methods to calculate NOI, but both models are constructed to test influence on appraisal value. Model 3-1 is called forward looking method while a transaction is going on, which NOI equals cap rate multiplies price.[59] On the other hand, Model 3-2 is backward looking method most likely for

[59] Forward looking method: NOI = Cap Rate x Price

refinancing, inhere NOI equals debt service ratio multiplies loan amount.[60] Office Index shows almost the exact same movement in both models, so does All-Property Index. However, Retail Index reports difference between two models.

Exhibit 4-9

Model 3-2: Appraisal w/Transactions excluding Ratio=1 (Sale-Backward Looking)

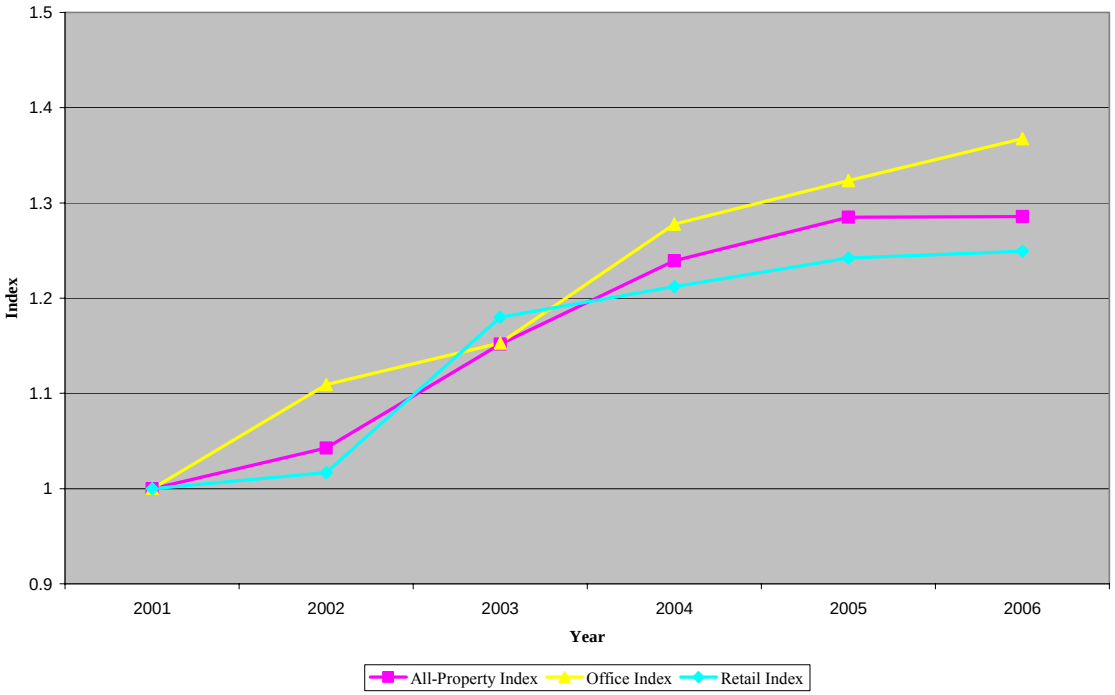
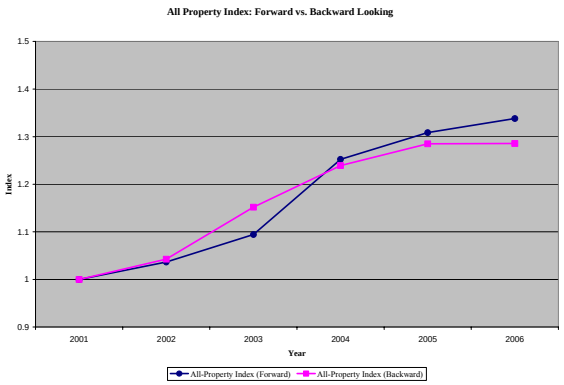
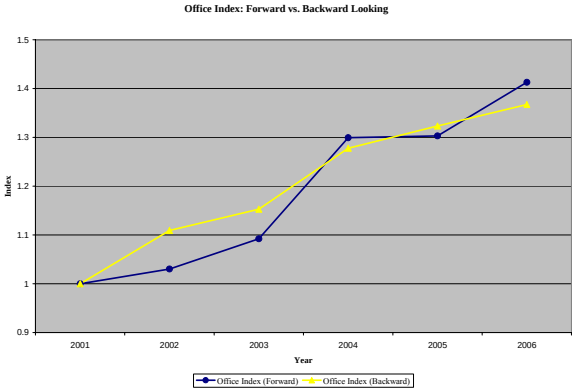
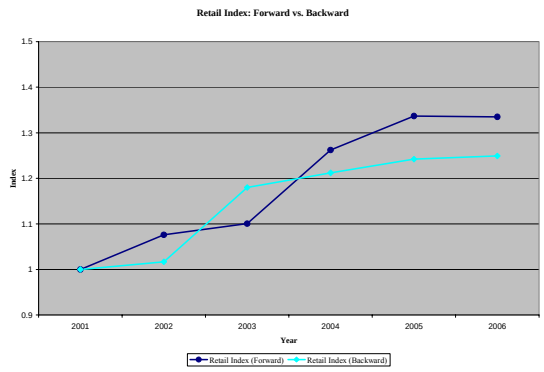


Exhibit 4-10 Forward vs. Backward





[60] Backward looking method: NOI = DSCR x Loan Amount



From comparing forward looking with backward looking models, I note that appraisal price of forward is slightly higher than of backward one, especially in All-Property Index and Retail Index charts shown on Exhibit 4-10. The exception is for Office Index. I believe the test result permits a termination of appraiser behavior. Normally, appraisers have more pressure on during the appraisal process when there is a transaction coming. Appraisers set their valuation rules based on recent purchase data, and then adjust any errors in previous periods when the purpose of appraisal is for refinancing (backward looking). According to Chinloy, Cho & Megbolugbe (1997), appraisers will reduce future appraisals price if they overappraised properties.[61] As a conclusion, appraisers make adjustments based on whether they have overappraised or underappraised in the recent past. On the other hand, a high DSCR can give appraisers pressure respectively, and thus they will appraise lower than should be. Because lenders rely on appraisals to justify loan decisions and appraisers have to make lenders happy at the end.[62] For example, if lender thinks a $100 appraised value property accounts for $90, the lender won't let the deal go through.

Exhibit 4-11 and 4-12 report results of regression analysis. Both models have consistent coefficients nearly on all variables. Comparing coefficient of NOI, there is not much difference between two models. NOI is still the dominant variable in both models as previous analysis, which is within my expectation. Property location, age and supply constraint are significant

[61] Chinoly, Cho and Megbolugbe (1997), Appraisals, Transaction Incentives, and Smoothing, *Journal of Real Estate Finance and Economics, 14: pp 105.*
[62] Normally appraiser would know the amount of the loan at the time when they are doing the appraisal.

variables as well. Surprisingly, property size does not influence the appraisal price very much, different comparing with refinancing model. The reason is not clear, however, sample criteria may affect the result. With this in mind, this model (model 3) excludes all properties with the ratio of appraisal and transaction price equal 1.

Exhibit 4-11
Regression Result of Model 3-1: Appraisal excluding Ratio =1 (Sale Forward Looking)

Hedonic Variables	All Property	Office	Retail
COEFFICIENT	LnAppraisal	LnAppraisal	LnAppraisal
LnNOI_Fwd	1.013***	0.980***	0.992***
	[0.014]	[0.027]	[0.025]
LnSqft	-0.0016	0.0484*	-0.0005
	[0.013]	[0.029]	[0.021]
Reno_Dum	0.00611	0.0216	-0.000672
	[0.014]	[0.023]	[0.025]
Age5to10	-0.0229	-0.0015	-0.0361
	[0.020]	[0.043]	[0.030]
Age10to30	-0.0386**	-0.0950***	-0.0286
	[0.017]	[0.035]	[0.027]
Age30to50	-0.0504**	-0.105**	-0.0297
	[0.023]	[0.044]	[0.041]
AgeGreaterThan50	-0.0712*	-0.153***	0.108
	[0.037]	[0.057]	[0.069]
cbd_fg	0.0652***	0.0719**	0.121**
	[0.025]	[0.034]	[0.055]
MultiTenant	-0.0192	-0.0245	-0.011
	[0.014]	[0.021]	[0.023]
Malpezzi98	0.0137***	0.0222***	0.0118***
	[0.0023]	[0.0039]	[0.0041]
Apt_Dum	0.0784***		
	[0.022]		
Ret_Dum	0.0407*		
	[0.023]		
Off_Dum	-0.011		
	[0.022]		
Period_2002	0.0361	0.0299	0.0732
	[0.038]	[0.060]	[0.076]
Period_2003	0.0901**	0.0882	0.0958
	[0.041]	[0.066]	[0.082]
Period_2004	0.225***	0.262***	0.233***
	[0.037]	[0.060]	[0.073]
Period_2005	0.269***	0.265***	0.290***
	[0.032]	[0.049]	[0.066]
Period_2006	0.291***	0.346***	0.289***
	[0.032]	[0.050]	[0.066]
Constant	1.998***	1.696***	2.324***
	[0.11]	[0.18]	[0.21]

Observations	989	309	382
R-squared	0.96	0.97	0.95

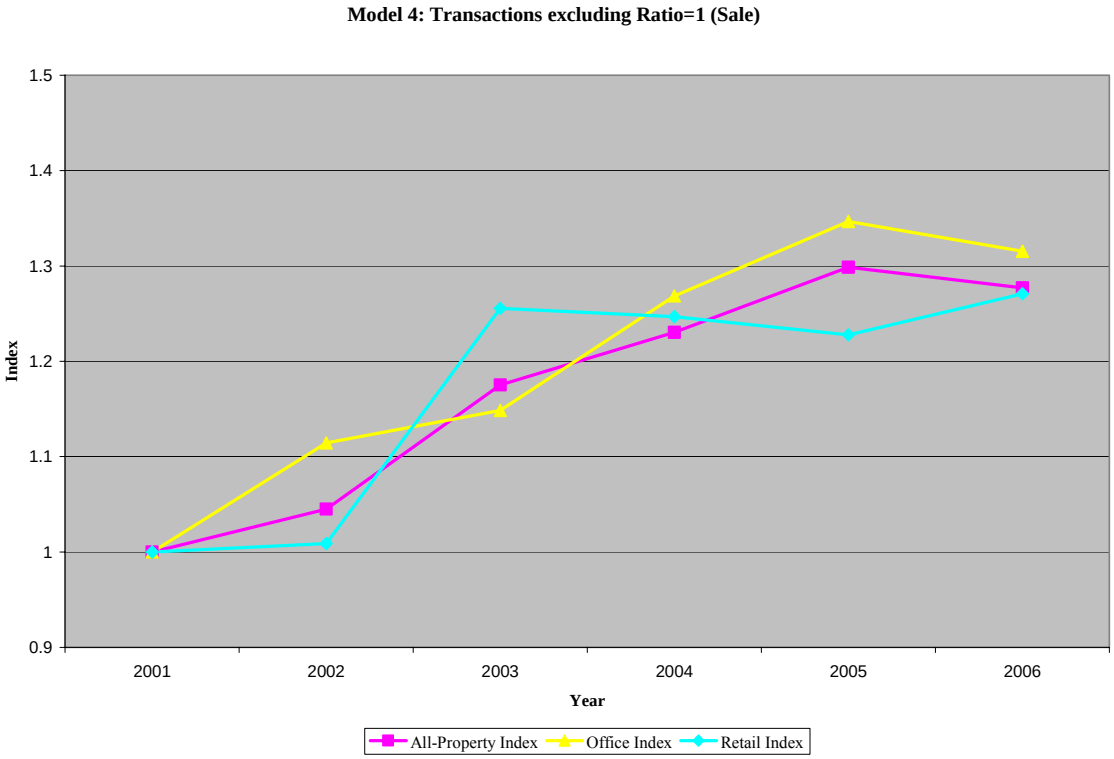
Exhibit 4-12
Regression Result of Model 3-2: Appraisal excluding Ratio =1 (Sale Backward Looking)

Hedonic Variables	All Property	Office	Retail
COEFFICIENT	LnAppraisal	LnAppraisal	LnAppraisal
LnNOI_Bwd	1.007***	0.954***	1.010***
	[0.012]	[0.027]	[0.014]
LnSqft	0.0108	0.0974***	-0.015
	[0.011]	[0.029]	[0.012]
Reno_Dum	0.00822	0.00303	0.00509
	[0.012]	[0.024]	[0.014]
Age5to10	-0.0191	-0.00991	-0.0310*
	[0.017]	[0.044]	[0.017]
Age10to30	-0.0410***	-0.0742**	-0.0365**
	[0.014]	[0.036]	[0.016]
Age30to50	-0.0370*	-0.0371	-0.00356
	[0.019]	[0.046]	[0.024]
AgeGreaterThan50	-0.120***	-0.185***	0.0287
	[0.031]	[0.059]	[0.040]
cbd_fg	0.111***	0.105***	0.120***
	[0.021]	[0.035]	[0.032]
MultiTenant	0.00523	-0.0202	0.0172
	[0.012]	[0.022]	[0.013]
Malpezzi98	0.0109***	0.0196***	0.00442*
	[0.0020]	[0.0040]	[0.0024]
Apt_Dum	0.0640***		
	[0.018]		
Ret_Dum	0.0347*		
	[0.019]		
Off_Dum	0.0306*		
	[0.019]		
Period_2002	0.0418	0.104*	0.0167
	[0.032]	[0.062]	[0.044]
Period_2003	0.141***	0.142**	0.166***
	[0.035]	[0.068]	[0.047]
Period_2004	0.215***	0.245***	0.192***
	[0.031]	[0.062]	[0.042]
Period_2005	0.251***	0.280***	0.217***
	[0.027]	[0.051]	[0.038]
Period_2006	0.251***	0.313***	0.223***
	[0.027]	[0.051]	[0.038]
Constant	4.513***	3.951***	4.943***
	[0.087]	[0.18]	[0.10]
Observations	989	309	382
R-squared	0.97	0.97	0.98

Standard errors in brackets
*** p<0.01, ** p<0.05, * p<0.1

4.3.4 Analysis of National Sale Transaction excluding Ratio=1 Indexes (Model 4)

Exhibit 4-13



The graphical depictions of these indexes in Exhibit 4-13 reveal a generally steady upward climb during period of 2001-2005, with a downward between 2005 and 2006. The Retail Index is an exception with an unexpected jump in 2003 and a surprisingly downturn from 2003 to 2005, then a bounce-back between 2005 and 2006. As noted, there is a certain level "noise" in the Retail Index, which is the odd man out in this grouping. With this in mind, sample size for this model is quite small, and thus a certain level "noise" can not be avoided.

The table in Exhibit 4-14 presents the regression results summaries for transaction-based indexes. As before, NOI again is the most significant variable in the analysis no matter in which property types. Other property characteristics, such as property size, age, location, number of tenants and supply constrain, have a secondary influence on price.

Exhibit 4-14 Regression Result of Model 4: Transaction excluding Ratio =1 (Sale)

Hedonic Variable	All Property	Office	Retail
COEFFICIENT	LnPrice	LnPrice	LnPrice
LnNOI	0.951***	0.924***	0.937***
	[0.016]	[0.035]	[0.023]
LnSqft	0.0466***	0.121***	0.0302
	[0.015]	[0.038]	[0.020]
Reno_Dum	0.0049	-0.0211	0.00905
	[0.016]	[0.031]	[0.024]
Age5to10	-0.0419*	-0.0278	-0.0452
	[0.023]	[0.057]	[0.029]
Age10to30	-0.0811***	-0.0554	0.104***
	[0.019]	[0.047]	[0.027]
Age30to50	-0.0906***	-0.0245	-0.0612
	[0.026]	[0.060]	[0.040]
AgeGreaterThan50	-0.173***	-0.137*	-0.0862
	[0.043]	[0.077]	[0.068]
cbd_fg	0.125***	0.0761*	0.120**
	[0.028]	[0.045]	[0.054]
MultiTenant	0.0348**	0.00551	0.0475**
	[0.016]	[0.029]	[0.022]
Malpezzi98	0.0115***	0.0181***	0.00448
	[0.0027]	[0.0052]	[0.0041]
Apt_Dum	0.0867***		
	[0.025]		
Ret_Dum	0.0587**		
	[0.026]		
Off_Dum	0.0824***		
	[0.025]		
Period_2002	0.0441	0.108	0.00896
	[0.045]	[0.084]	[0.083]
Period_2003	0.162***	0.139	0.228***
	[0.048]	[0.086]	[0.085]
Period_2004	0.207***	0.238***	0.221***
	[0.047]	[0.087]	[0.084]
Period_2005	0.261***	0.298***	0.205***
	[0.039]	[0.069]	[0.074]
Period_2006	0.245***	0.274***	0.240***
	[0.039]	[0.069]	[0.073]
Constant	4.658***	4.033***	5.212***
	[0.12]	[0.24]	[0.18]
Observations	989	309	382
R-squared	0.95	0.95	0.95

Standard errors in brackets
*** p<0.01, ** p<0.05, * p<0.1

However, these estimated coefficients should not be interpreted as multipliers, since other property charcteristics also explain variation in market values. Similar to model 2, CBD location

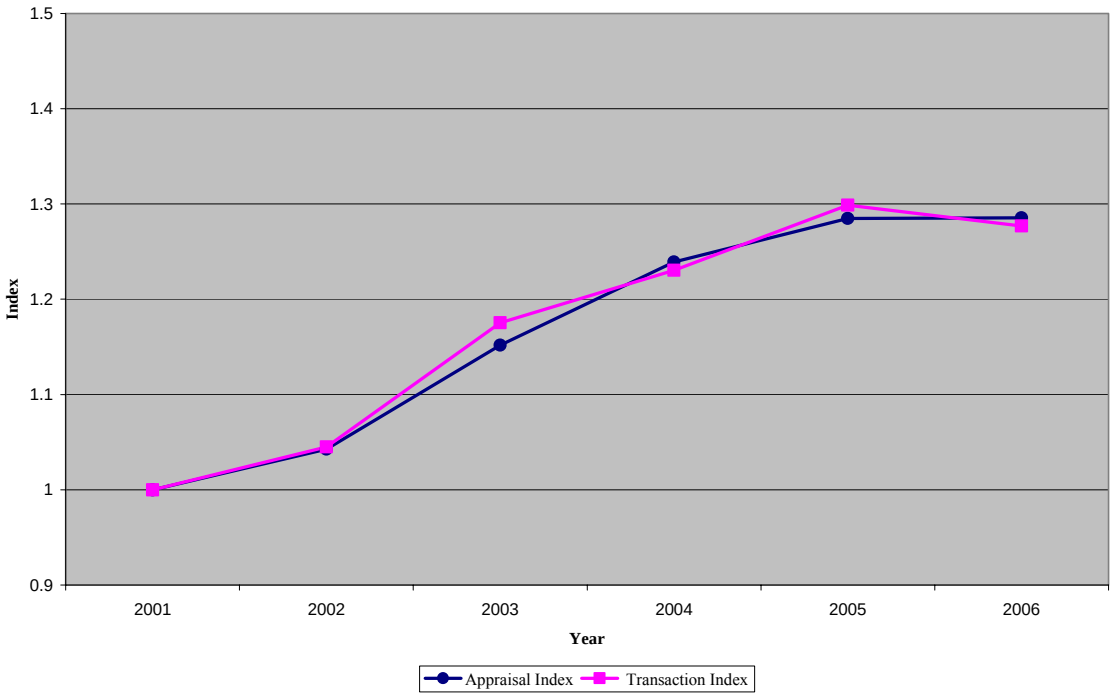
and number of tenants do not affect property sale price as strong as other characteristics mentioned above. For All-Property Index, apartment, office and retail have higher prices than industrial sector. The year of sale coefficients indicate that property sale prices increase during this period, is consistent with my expectation.

4.4 Indexes Comparison

4.4.1 Comparison between Appraisal Indexes and Transaction Indexes

Exhibit 4-15

Appraisal vs. Transaction Indexes (All-Property National)



As mentioned in Chapter 3, model 3 and 4 have the exact same observations for the purpose of this comparison. Again, dependable variable for model 3 is appraisal value, and for model 4 is transaction price. In a light of 'apple-to-apple' comparison, method of calculation NOI in both models is backward looking.

In the All-Property Index graphic of Exhibit 4-15, transaction index shows slightly higher growth than appraisal index in 2005 and lower in 2006. The little difference cannot prove if two indexes are cointegrated or not. However, if appraisal is higher than sale price, a rising real estate market would be expected, otherwise, a down market is coming. The underlying hypothesis is that purchase and appraisal prices draw from separate distributions, the data appear to bear out this hypothesis. Exhibit 4-15 depicts that their movements are consistent during this period, therefore appraisal growth rates are cointergrated with purchase growth rates. However, transaction index starts lower and stops higher than appraisal between 2004 and 2005.

Compared with appraisal indices, transaction indices show more volatility. In addition, Exhibit 4-16, 4-17, 4-18 present that appraiser values income more than the market (LnNOI = 1.007 >0.951), which proves that appraisers pay more attention to income than the buyers and sellers do. Size of the property affects the sale price in All-Property Index, but not appraisal value so does number of tenants. For office sector, property size influence both sale price and appraisal. Larger buildings sell at premiums relative to smaller buildings. CBD location influences more on sale price than on appraisal for all property level, but appraisers take more account for location than the market does in both office and retail property type sectors. As mentioned earlier, supply constraint matters significantly on price. While comparing coefficients on both models, I find that appraisers take less account of the supply constraint than the market does for all property, but more for office sector. The exception is retail; it seems that regulation does not affect retail development as much as others.

Exhibit 4-16 All-Property Index Regression Results: Transaction vs. Appraisal Indexes

Hedonic Variable	All Property	All Property
COEFFICIENT	LnPrice	LnAppraisal
LnNOI	0.951***	1.007***
	[0.016]	[0.012]
LnSqft	0.0466***	0.0108
	[0.015]	[0.011]
Reno_Dum	0.0049	0.00822
	[0.016]	[0.012]
Age5to10	-0.0419*	-0.0191
	[0.023]	[0.017]
Age10to30	-0.0811***	-0.0410***
	[0.019]	[0.014]
Age30to50	-0.0906***	-0.0370*
	[0.026]	[0.019]
AgeGreaterThan50	-0.173***	-0.120***
	[0.043]	[0.031]
cbd_fg	0.125***	0.111***
	[0.028]	[0.021]
MultiTenant	0.0348**	0.00523
	[0.016]	[0.012]
Malpezzi98	0.0115***	0.0109***
	[0.0027]	[0.0020]
Apt_Dum	0.0867***	0.0640***
	[0.025]	[0.018]
Ret_Dum	0.0587**	0.0347*
	[0.026]	[0.019]
Off_Dum	0.0824***	0.0306*
	[0.025]	[0.019]
Period_2002	0.0441	0.0418
	[0.045]	[0.032]
Period_2003	0.162***	0.141***
	[0.048]	[0.035]
Period_2004	0.207***	0.215***
	[0.047]	[0.031]
Period_2005	0.261***	0.251***
	[0.039]	[0.027]
Period_2006	0.245***	0.251***
	[0.039]	[0.027]
Constant	4.658***	4.513***
	[0.12]	[0.087]
Observations	989	989
R-squared	0.95	0.97

Exhibit 4-17 Office Index Regression Results: Transaction vs. Appraisal Indexes

Hedonic Variable	Office	Office
COEFFICIENT	LnPrice	LnPrice
LnNOI	0.924***	0.954***
	[0.035]	[0.027]
LnSqft	0.121***	0.0974***
	[0.038]	[0.029]
Reno_Dum	-0.0211	0.00303
	[0.031]	[0.024]
Age5to10	-0.0278	-0.00991
	[0.057]	[0.044]
Age10to30	-0.0554	-0.0742**
	[0.047]	[0.036]
Age30to50	-0.0245	-0.0371
	[0.060]	[0.046]
AgeGreaterThan50	-0.137*	-0.185***
	[0.077]	[0.059]
cbd_fg	0.0761*	0.105***
	[0.045]	[0.035]
MultiTenant	0.00551	-0.0202
	[0.029]	[0.022]
Malpezzi98	0.0181***	0.0196***
	[0.0052]	[0.0040]
Period_2002	0.108	0.104*
	[0.084]	[0.062]
Period_2003	0.139	0.142**
	[0.086]	[0.068]
Period_2004	0.238***	0.245***
	[0.087]	[0.062]
Period_2005	0.298***	0.280***
	[0.069]	[0.051]
Period_2006	0.274***	0.313***
	[0.069]	[0.051]
Constant	4.033***	3.951***
	[0.24]	[0.18]
Observations	309	309
R-squared	0.95	0.97

Exhibit 4-18 Retail Index Regression Results: Transaction vs. Appraisal Indexes

Hedonic Variable	Retail	Retail
COEFFICIENT	LnPrice	LnApprisal
LnNOI	0.937***	1.010***
	[0.023]	[0.014]
LnSqft	0.0302	-0.015
	[0.020]	[0.012]
Reno_Dum	0.00905	0.00509
	[0.024]	[0.014]
Age5to10	-0.0452	-0.0310*
	[0.029]	[0.017]
Age10to30	0.104***	-0.0365**
	[0.027]	[0.016]
Age30to50	-0.0612	-0.00356
	[0.040]	[0.024]
AgeGreaterThan50	-0.0862	0.0287
	[0.068]	[0.040]
cbd_fg	0.120**	0.120***
	[0.054]	[0.032]
MultiTenant	0.0475**	0.0172
	[0.022]	[0.013]
Malpezzi98	0.00448	0.00442*
	[0.0041]	[0.0024]
Period_2002	0.00896	0.0167
	[0.083]	[0.044]
Period_2003	0.228***	0.166***
	[0.085]	[0.047]
Period_2004	0.221***	0.192***
	[0.084]	[0.042]
Period_2005	0.205***	0.217***
	[0.074]	[0.038]
Period_2006	0.240***	0.223***
	[0.073]	[0.038]
Constant	5.212***	4.943***
	[0.18]	[0.10]
Observations	382	382
R-squared	0.95	0.98

4.4.2 Comparison between Appraisals Indexes w/o Transaction (Refinancing) and w/Transaction (Sale)

Exhibit 4-19

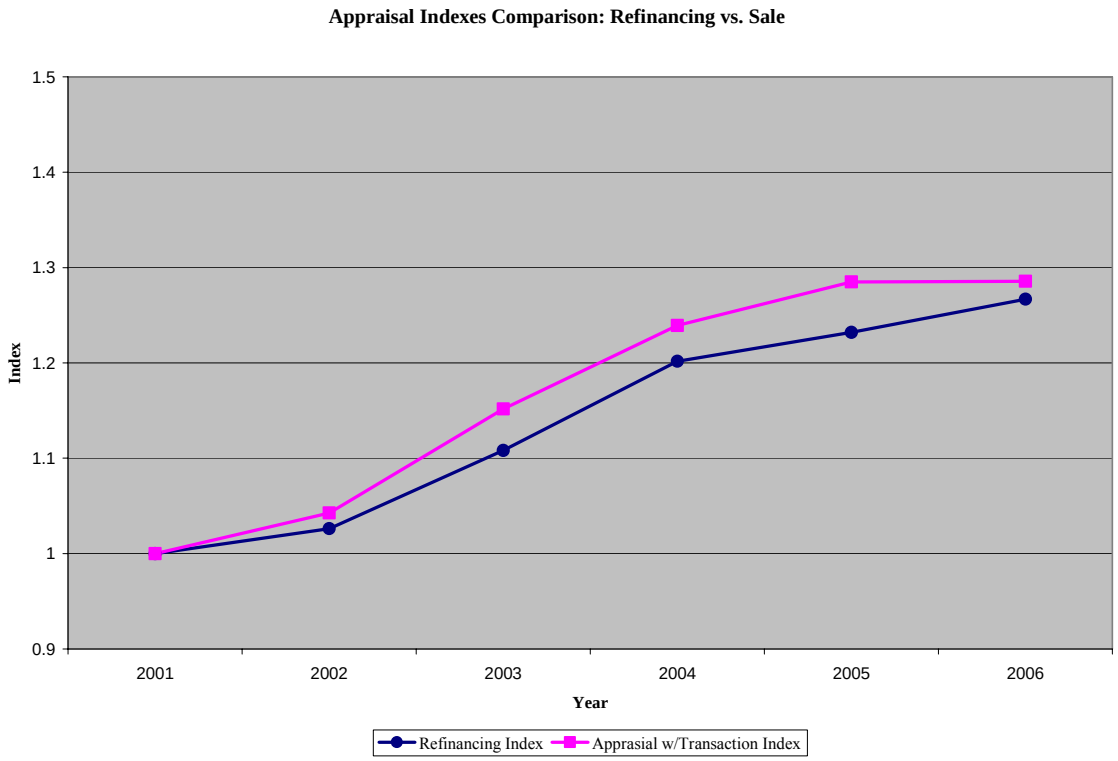


Exhibit 4-19 shows that appraisal price is much higher when a transaction involved in All-Property Indices. Appraisers have more pressure when there is a transaction occurred comparing with only for refinancing deal, which proves my early conclusion again. Normally, if there is a transaction on the way, appraisers will act differently. They will appraise properties value higher than refinancing properties, which will make both sellers and buyers happy.

From the comparison regression results shown on Exhibit 4-20, we can see that appraisers care more on net cash flow (income) for properties with transactions than without sales. Property size matters significantly for refinancing properties, but not for properties with transaction. Supply

constraint matters more on refinancing deals than on sale properties, which is inconsistent with my expectation, so does property location.

Exhibit 4-20 Appraisal Comparison: Refinancing vs. Sale (All-Property National)

Hedonic Variables	Refinancing	Sale
COEFFICIENT	LnAppraisal	LnAppraisal
LnNOI_Bwd	0.738*** [0.0057]	1.007*** [0.012]
LnSqft	0.213*** [0.0054]	0.0108 [0.011]
Reno_Dum	0.0169** [0.0078]	0.00822 [0.012]
AppAge5to10	-0.0535*** [0.010]	-0.0191 [0.017]
AppAge10to30	-0.0946*** [0.0083]	-0.0410*** [0.014]
AppAge30to50	-0.107*** [0.012]	-0.0370* [0.019]
AppAgeGreaterThan50	-0.0776*** [0.015]	-0.120*** [0.031]
cbd_fg	0.156*** [0.012]	0.111*** [0.021]
MultiTenant	-0.0123 [0.0081]	0.00523 [0.012]
Malpezzi98	0.0265*** [0.0011]	0.0109*** [0.0020]
Apt_Dum	0.387 [0.27]	0.0640*** [0.018]
Ret_Dum	0.296*** [0.010]	0.0347* [0.019]
Off_Dum	0.272*** [0.011]	0.0306* [0.019]
Period_2002	0.0258* [0.013]	0.0418 [0.032]
Period_2003	0.103*** [0.014]	0.141*** [0.035]
Period_2004	0.184*** [0.014]	0.215*** [0.031]
Period_2005	0.209*** [0.012]	0.251*** [0.027]
Period_2006	0.237*** [0.014]	0.251*** [0.027]
Constant	4.704*** [0.045]	4.513*** [0.087]
Observations	8539	989
R-squared	0.92	0.97

4.4.3 Comparison between Appraisal Index w/o Transaction and Transaction Index

Exhibit 4-21 shows that transaction index leads appraisal index as previous comparison. With this in mind, this appraisal index excludes transactions, which is only for refinancing properties. As shown on Exhibit 4-21, appraisal index has lagging issue, which means appraisal has the same incline but occurs one period after transaction index.

It that is true, we can predict appraisal index will drop between 2006 and 2007, even though we only have data till 2006. I think this lagging issue is due to appraisers behavior, because, they basically use previous transaction cash flow information when appraisers look at those refinancing properties.

Exhibit 4-21

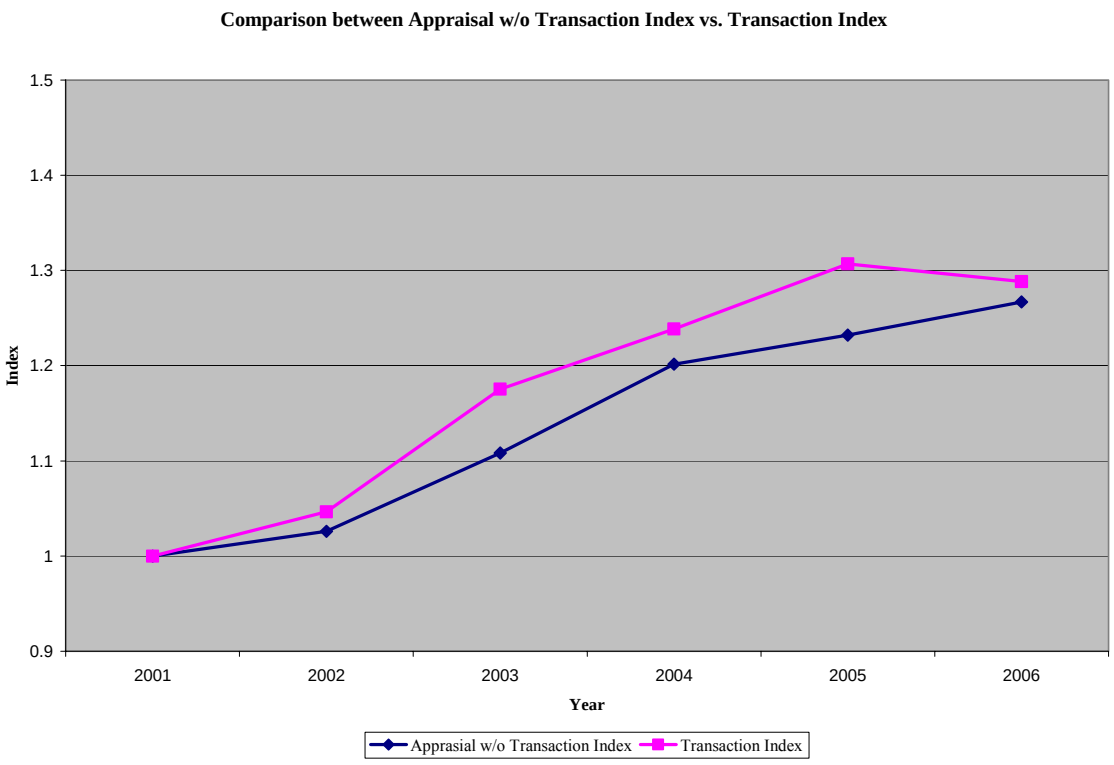


Exhibit 4-22 Comparison: Appraisal w/o Transaction (Refinancing) vs. Transaction Index (All-Property National)

Hedonic Variables	Appraisal w/o Transaction Index	Transaction Index
COEFFICIENT	LnAppraisal	LnPrice
LnNOI_Bwd	0.738*** [0.0057]	0.960*** [0.014]
LnSqft	0.213*** [0.0054]	0.0377*** [0.012]
Reno_Dum	0.0169** [0.0078]	-0.00301 [0.014]
AppAge5to10	-0.0535*** [0.010]	-0.0437** [0.019]
AppAge10to30	-0.0946*** [0.0083]	-0.0760*** [0.017]
AppAge30to50	-0.107*** [0.012]	-0.0882*** [0.023]
AppAgeGreaterThan50	-0.0776*** [0.015]	-0.130*** [0.036]
cbd_fg	0.156*** [0.012]	0.106*** [0.024]
MultiTenant	-0.0123 [0.0081]	0.0264** [0.013]
Malpezzi98	0.0265*** [0.0011]	0.0121*** [0.0023]
Apt_Dum	0.387 [0.27]	0.0763*** [0.021]
Ret_Dum	0.296*** [0.010]	0.0585*** [0.022]
Off_Dum	0.272*** [0.011]	0.0617*** [0.021]
Period_2002	0.0258* [0.013]	0.0455 [0.042]
Period_2003	0.103*** [0.014]	0.161*** [0.043]
Period_2004	0.184*** [0.014]	0.214*** [0.042]
Period_2005	0.209*** [0.012]	0.268*** [0.037]
Period_2006	0.237*** [0.014]	0.253*** [0.036]
Constant	4.704*** [0.045]	4.664*** [0.10]
Observations	8539	1262
R-squared	0.92	0.96

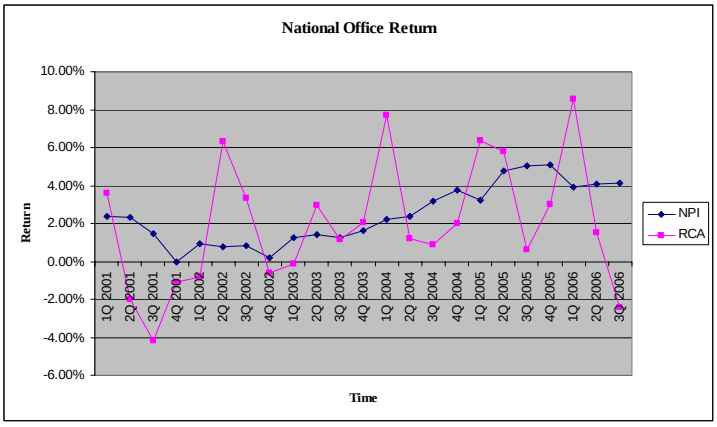
From the comparison regression results shown on Exhibit 4-22, we can see that appraisers care more on net cash flow (income) for properties with transactions than refinancing, NOI for transaction is 0.96 close to 1 comparing with 0.73 for refinancing one. Property size matters significantly for refinancing properties, but not as much as for properties with transaction. Supply constraint matters more on refinancing deals than on sale properties, which is inconsistent with my expectation, so does property location. Number of tenants influence significantly for transaction, but not for refinancing.

4.4.4 Comparison between RCA Appraisal Index and NCREIF Index

As mentioned in Chapter 1, even though NCREIF index consists of both equity and leveraged properties, actually the NPI is completely unleveraged due to those leveraged properties reported on an unleveraged basis. Appraisal index in this thesis is purely leveraged. NCREIF appraisal are based on market value and appraisers do not pay attention to NPI, so NCREIF index is not influenced by appraisers behavior as much as RCA appraisal indexes. NPI is based on appraisal valuations of the constituent properties of the index not appraisers behavior. Moreover, not every peroperty is reappraised every period in NPI. Therefore, NPI present actual market value with a lag issue. In addition, the NPI covers less than $300 billion worth of commercial properties[63], RCA collect all more than $2.5 million commercial properties, which covers a larger population than NCREIF. Exhibit 4-23 depicts that RCA index is more volatile than the NPI, and the NPI has a lagging issue compared with RCA index.

[63] See Geltner & Pollakowski (2006), A Set of Indexes for Trading Commercial Real Estate Based on the Real Capital Analytics Transaction Prices Database, *pg 2.*

Exhibit 4-23 National Office Indexes Return



Chapter Five: Conclusion

The purpose of this thesis is to address the characteristics of a transaction-based index of commercial real estate and to compare appraisal and transaction price in the CMBS market. Fewer researches have been done in this interest due to limited data and various shortcomings in the CMBS market. With the support from RCA, this study has overcame those problems by obtaining a relatively large data set of transaction properties.

As shown in those regression results, I notice that the transaction-based index reflects the timing and changes of market price more accurately and effectively than appraisal-based index does during the examination period. Furthermore, transaction-based indices can avoid those problems appraisal indices have, such as lag smoothing. My findings suggest a transaction-based index is much more volatile than the appraisal-based index. Comparing two appraisal indices, the one without transactions (refinancing) is less volatile than the one with transactions (sale). The underlying reason is appraisers have more pressure when there is a transaction occurred comparing with only for refinancing deal. Therefore, they will appraise those properties with transactions higher than refinancing ones.

In addition, after comparing appraisal index without transaction (refinancing) and transaction index (sale), I learn that transaction index for sure leads appraisal index at least one period due to its lagging issue. Therefore, we can predict appraisal index return based on transaction index.

In studying the characteristics of a commercial real estate market, I find that NOI has the primary influence on price among all listed characteristics in previous chapters. It's very clear to

conclude that NOI is the most significant variable on transaction price because NOI is able to capture any benefits or risks occurred in the future. Despite the determinant role of NOI, other property characteristics have a secondary influence on price because they are associated with property investments. Those characteristics that reduce risks will increase market values or income, otherwise, will decrease property value. In different situations, those dummy variables act differently, which help us to understand the market. Again, those characteristics can be various in different studies, here are property size, location, age, supply constraint, number of tenants and so on.[64]

It's proved that the relationship between appraisal and transaction is defined by market and appraisers behavior. When appraisal is higher than transaction price, a bull market is expected, otherwise, a down market is coming. As noted, appraisers behavior affect appraisal price impressively, they make adjustments based on their previous appraisals in the past. When appraisers look at those refinancing properties, they basically use previous transaction cash flow information, which causes appraisal index (refinancing) has lag issue. However when there is a transaction involved, appraisers are more careful and they use market cash flow, therefore there is no lagging issue in appraisal index with transaction. Obviously, we can not ignore this matter for further studies. For examination of long-run relationship between them, we need to construct a more sophisticated regression model with more qualified transaction data. This is also applied to compare different appraisal indices, such as refinancing and sale ones I mentioned earlier.

Hedonic regression analysis is a useful tool for estimating property value behavior in the commercial real estate market, even though limitations of its application still exist for both

[64] Check Chapter 3 for the whole list in details.

academic and practical use. However, with better data collection, regression analysis will provide additional opportunities for commercial real estate.

For further study, I recommend in several areas. First, since appraisers have first-hand information of loan, it's great to use loan structure as one of dummy variables to test its influence on market value. According to Merrill Lynch, more than 75% of the CMBS loans that have paid off have been refinanced by loans that were securitized in deals issued in 2005 and 2006. In addition, loan interest rate should be a secondary influence on price, especially for refinancing deals. According to Merrill Lynch, property owners have benefited from lower interest rates. 30% reductions in their rates in those loans refinanced between 2003 and 2005, 20% reductions in 2006 and 17% reductions this year.[65] Third, some loan issuers have more aggressive appraisals than others. To add issuers into regression specification will be able to test their influence on price.

And interest-only (IO) periods are now far- more rampant than before. Normally, appraisers are more aggressive while dealing with IO deals than non-IO deals. It will be interesting to examine IO deal's influence on refinancing properties. Another recommendation is to examine investor types associated with certain risks. Some types of investor can bear higher risks than others.

Again, the real estate cycle is about ten years, but this thesis is limited to years of 2000 to 2006. In order to draw more conclusions and find underlying relationship between appraisal and

[65] Quoted from Commercial Real Estate Direct, Refinance Activity Shows How Borrowers Have Benefited, *March 22, 2007.*

transaction, it is better to have more qualified transaction data in a longer period. Therefore, less error will occur and more supportive analysis can be done.

It is highly recommended that similar research can be continued in the near future and be conducted again in a different way or for different periods.

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Real Capital Analytics (RCA) Capital Trends Monthly report of May 2007.

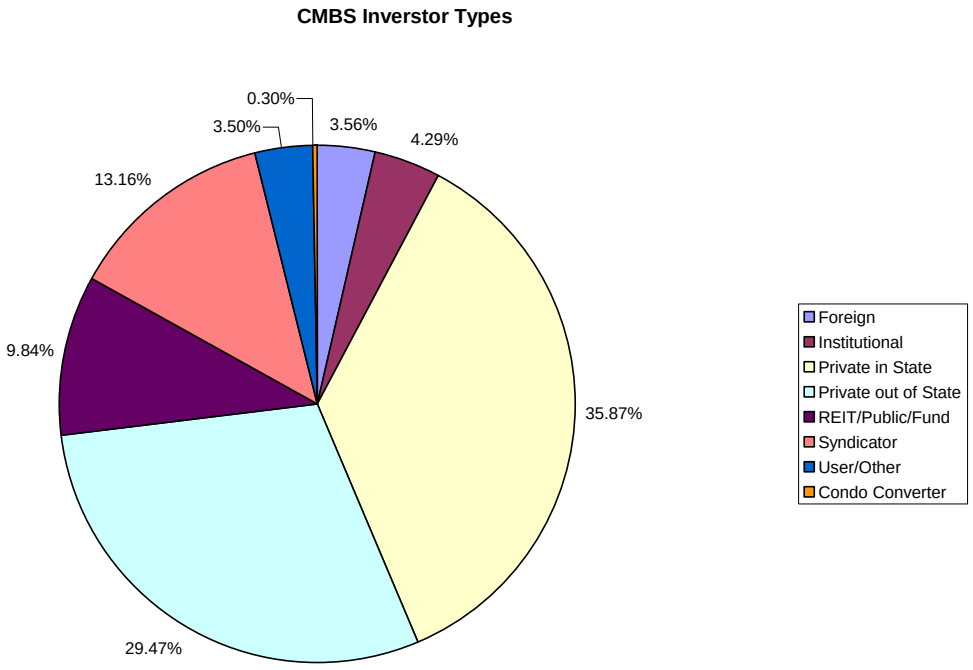
Appendix A – Variables list in RCA data set

Variable Name	Variable Label	Obs (Total)	Obs (CMBS)	Obs (CMBS-Sale)
Total		**101,797**	**31,154**	**3,530**
address_tx	Address_tx	100909	30792	3527
buyerassumedd~t	BuyerAssumedDebt	101795	31152	3528
buyerinvcomp	BuyerInvComp	63444	3047	3047
buyerjv	BuyerJV	7402	457	457
buyername1	BuyerName1	69302	3235	3234
buyername2	BuyerName2	7361	456	456
buyerobjective	BuyerObjective	7671	80	80
capqualifyer	CapQualifyer	46428	27797	2959
caprate	CapRate	46428	27797	2959
cbd_fg	CBD_fg	101795	31152	3528
cbsa_cd	CBSA_cd	100585	30645	3491
city_tx	City_tx	101573	31121	3527
cmbs_appraise~e	CMBS_AppraisedValue	31152	31152	3528
cmbs_fg	CMBS_fg	101795	31152	3528
cmbs_issue_tx	CMBS_Issue_tx	31152	31152	3528
comments_tx	Comments_tx	3351	156	152
county_nm	County_nm	101369	31040	3521
deal_id	Deal_id	101795	31152	3528
deal_update_dt	Deal_Update_dt	101795	31152	3528
dealqualifyer	DealQualifyer	101786	31151	3527
devbldgs_nb	DevBldgs_nb	72	0	0
devcalcsqft	DevCalcSqFt	921	26	26
devcomments	DevComments	384	8	8
devcomplete_dt	DevComplete_dt	36	0	0
devfloors_nb	DevFloors_nb	34	0	0
devmaintype	DevMainType	1426	42	42
devprioruse_tx	DevPriorUse_tx	4	0	0
devsubtype1	DevSubType1	1426	42	42
devsubtype2	DevSubType2	283	5	5
dscr_nb	DSCR_nb	24102	22820	2333
excess_land_p~g	Excess_Land_Potential_fg	101795	31152	3528
fips_cd	FIPS_cd	101366	30968	3526
hotelfranchis~m	HotelFranchise_nm	4253	117	117
improvedcomme~x	ImprovedComments_tx	67	0	0
improvedtype_tx	ImprovedType_tx	701	6	6
intconvey_tx	IntConvey_tx	2394	141	103
intconveyed_nb	IntConveyed_nb	950	72	72
land_area_acr~b		48994	2455	2454
lat_nb	Lat_nb	101565	31050	3527
lender	Lender	53916	29535	3302
lender_commen~x	Lender_Comments_tx	1632	26	26
lender_int_ra~x	Lender_Int_Rate_Type_tx	51409	29050	3153
lender_intere~b	Lender_Interest_Rate_nb	33965	31016	3491
lender2_tx	Lender2_tx	1554	20	20
loan_amort_or~b	Loan_Amort_Orig_nb	26584	25515	2080

loan_amt	Loan_amt	28290	11911	1226
loan_cross_de~g	Loan_Cross_Default_fg	101795	31152	3528
loan_int_m~d_tx	Loan_Int_Method_tx	26244	25574	2179
loan_int_m~o_tx	Loan_Int_Method_IO_tx	2587	2501	307
loan_lockbox_fg	Loan_Lockbox_fg	101795	31152	3528
loan_ltv_matu~b	Loan_LTV_Matur_nb	25777	24450	2513
loan_ltv_orig~b	Loan_LTV_Orig_nb	24710	24071	2023
loan_maturity~t	Loan_Maturity_dt	30921	30074	2480
loan_orig_dt	Loan_Orig_Dt	32130	30651	3027
loan_orig_io_~b	Loan_Orig_IO_Terms_nb	13540	12489	1753
loan_pi_payme~t	Loan_PI_Payment_amt	26353	25930	1889
loan_prepay_tx	Loan_PrePay_tx	27457	26117	2700
loan_rsv_eng_nb	Loan_Rsv_Eng_nb	3337	3011	1021
loan_rsv_repl~b	Loan_Rsv_Repl_nb	1452	1384	342
loan_rsv_ti_nb	Loan_Rsv_TI_nb	4800	4574	626
loan_term_mth~x	Loan_Term_Mths_tx	33049	30969	3484
loan2_amt	Loan2_amt	9651	504	504
loan2_comment~x	Loan2_Comments_tx	50	7	7
lon_nb	Lon_nb	101565	31050	3527
maintype	Main Type	101795	31152	3528
maxofappraise~e	MaxOfAPPRAISED DATE	27032	27032	3203
metro_div_cd	Metro_Div_cd	41004	10961	1137
mort_brokerag~e	Mort_Brokerage_Name	0	0	0
msa_cd	MSA_cd	97623	29180	3374
msa_metro_fg	MSA_Metro_fg	101795	31152	3528
mtg_space_nb	Mtg_Space_nb	1105	53	53
numberbldgs_nb	NumberBldgs_nb	30966	1548	1548
numberfloors_nb	NumberFloors_nb	45603	2248	2248
numberunits_nb	NumberUnits_nb	38348	9765	1232
occupancy_rate	Occupancy_rate	63027	30195	3283
originator_tx	Originator_tx	30726	30726	3422
otherdealterm~x	OtherDealTerms_tx	4464	243	243
outputcategory1	OutputCategory1	40231	13772	1495
percentprojec~t	PercentProjectCost	1415	57	57
portfolio	Portfolio	13761	667	667
price	Price	101795	31152	3528
priceperbldsqft	PricePerBldSqFt	921	26	26
priceperlanda~e	PricePerLandAcre	48994	2455	2454
priceperlands~t	PricePerLandSqFt	46718	2353	2352
prior_sale_dt	Prior_Sale_dt	21128	1138	1134
prior_sale_pr~t	Prior_Sale_Price_at	20706	1118	1114
property_id	Property_id	101795	31152	3528
property_nb	Property_nb	101795	31152	3528
property_upda~t	Property_Update_dt	101795	31152	3528
propertyname	PropertyName	101759	31151	3528
rca_markets_tx	RCA_Markets_tx	101461	31062	3521
rca_metros_tx	RCA_Metros_tx	101465	31062	3521
region	Region	101482	31064	3524
sellerinvcomp~n	SellerInvComposition	66658	3141	3140
sellerjv	SellerJV	5197	335	335

sellername1	SellerName1	67628	3185	3184
sellername2	SellerName2	5131	335	335
sqft_nb	SqFt_nb	83936	22301	3204
state_cd	State_cd	101657	31128	3528
status_dt	Status_dt	101795	31152	3528
status_tx	Status_tx	101795	31152	3528
subtype	SubType	101750	31117	3526
tenancy_tx		43551	17197	1919
tenant1	Tenant1	42248	20569	2007
tenant2	Tenant2	26459	15514	1167
tenant3	Tenant3	20579	13876	901
transtype_tx	TransType_tx	101797	31154	3530
website_tx	Website_tx	22	0	0
yearblt	YearBlt	97061	30855	3524
yearrenuexp_nb	YearRenuExp_nb	25030	11749	1209
zip_cd	Zip_cd	101434	31056	3525

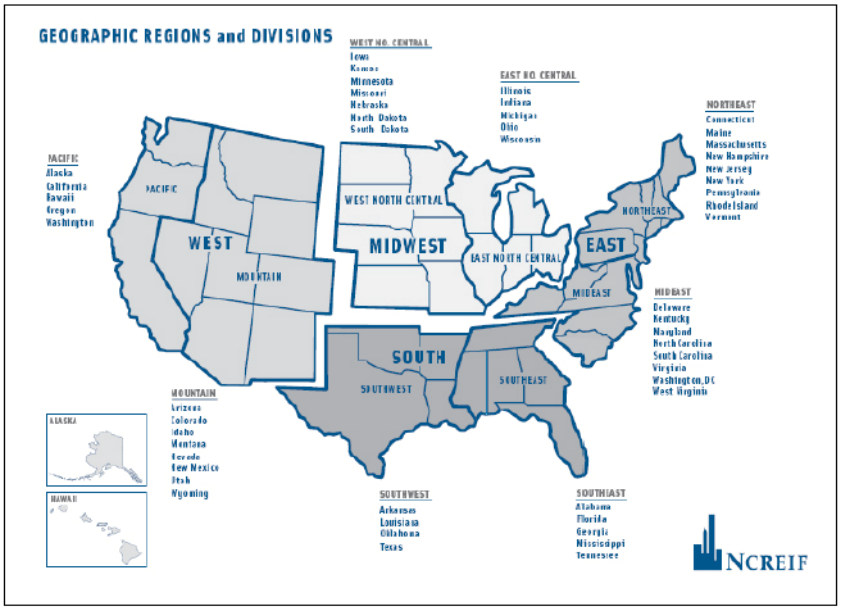
Appendix B – CMBS Investor Types



Buyer Types	Frequency	Percentage
Foreign	59	3.56%
Institutional	71	4.29%
Private in State	594	35.87%
Private out of State	488	29.47%
REIT/Public/Fund	163	9.84%
Syndicator	218	13.16%
User/Other	58	3.50%
Condo Converter	5	0.30%
Total	1,656	100.00%

Appendix C – Region Definitions

NCREIF Regions							
West		Midwest		South		East	
Pacific	Mountain	E.N. Central	W.N. Central	South West	South East	North East	Mid East
WA OR AK HI CA	MT ID WY UT CO NM AZ NV	 MI IL OH IN WI	 MN IA MO KS NE SD ND	 TX OK AR LA	TN GA FL AL MS	ME VT NH NY CT RI MA PA NJ DE	MD WV VA KY NC SC DC



Appendix D – Model Sample Size

Model 1

AppraisalYear	Others	Office	Retail	All Property
2001	139	186	357	682
2002	172	286	627	1085
2003	76	219	494	789
2004	79	231	645	955
2005	413	927	1974	3314
2006	222	482	1010	1714
Total	**1101**	**2331**	**5107**	**8539**

Model 2

Year	Others	Office	Retail	All Property
2001	11	13	8	32
2002	28	24	25	77
2003	18	23	19	60
2004	27	24	21	72
2005	129	130	168	427
2006	159	171	264	594
Total	**372**	**385**	**505**	**1262**

Model 3

AppraisalYear	Others	Office	Retail	All Property
2001	11	14	9	34
2002	27	22	21	70
2003	14	15	14	43
2004	32	22	29	83
2005	112	117	149	378
2006	102	119	160	381
Total	**298**	**309**	**382**	**989**

Model 4

Year	Others	Office	Retail	All Property
2001	11	13	7	31
2002	25	20	20	65
2003	14	18	16	48
2004	20	17	17	54
2005	111	110	138	359
2006	117	131	184	432
Total	**298**	**309**	**382**	**989**

Appendix E – Sample Descriptive Statistics

	Stats.	Appr. Value	Price	Cap Rate	NOI_fwd	NOI_Bwd	Sqft	Appraisal Age	Malpezzi98
M1	Mean	$ 19,620,949		7.56%		$ 109,746	108,961	19.92	21.78514
	Std. Dev.	$ 60,353,973		1.12%		$ 234,682	173,234	21.69	2.796102
	Min.	$ 2,500,000		3.59%		$ 9,156	1,100	1.00	17.05
	Max.	$ 1,850,000,000		11.96%		$ 5,299,840	2,941,646	224.00	28.692
M2	Mean		$ 23,116,318	7.17%		$ 113,744	145,852	19.18	21.24146
	Std. Dev.		$ 74,084,882	1.05%		$ 190,165	204,963	18.20	2.762909
	Min.		$ 2,500,000	3.74%		$ 13,239	4,701	1.00	17.05
	Max.		$ 1,720,000,000	11.50%		$ 2,415,891	2,840,000	157.00	28.692
M3	Mean	$ 24,196,340		7.22%	$ 1,544,965	$ 117,620	150,430	19.59	21.20449
	Std. Dev.	$ 74,442,605		1.06%	$ 3,727,752	$ 187,509	194,476	18.41	2.720619
	Min.	$ 2,565,000		3.74%	$ 160,446	$ 13,239	4,701	1.00	17.05
	Max.	$ 1,850,000,000		11.50%	$ 78,088,000	$ 2,415,891	2,840,000	157.00	28.692
M4	Mean		$ 22,936,101	7.22%		$ 117,620	150,430	19.69	21.20449
	Std. Dev.		$ 69,106,851	1.06%		$ 187,509	194,476	18.41	2.720619
	Min.		$ 2,500,000	3.74%		$ 13,239	4,701	1.00	17.05
	Max.		$ 1,720,000,000	11.50%		$ 2,415,891	2,840,000	157.00	28.692

Appendix F - Indexes Results

Model 1: National Appraisals w/o Transactions Indexes(Refinancing)

App. Year	All Index	Office Index	Retail Index	Returns All	Returns Office	Returns Retail
2001	1	1	1			
2002	1.026091	0.9952812	1.032952	0.0260913	-0.0047188	0.0329521
2003	1.108245	1.062079	1.125152	0.0800643	0.0671146	0.0892591
2004	1.201679	1.164798	1.213331	0.0843083	0.0967149	0.07837
2005	1.232078	1.209272	1.268103	0.0252973	0.0381818	0.0451425
2006	1.266912	1.235181	1.255397	0.0282727	0.0214249	-0.0100198
Total Ob.	8539	2331	5107			

Model 2: National Transactions w/ Ratio=1 Indexes(Sale)

Year	All Index	Office Index	Retail Index	Returns All	Returns Office	Returns Retail
2001	1	1	1			
2002	1.046556	1.125886	1.003155	0.046556	0.1258861	0.0031545
2003	1.175259	1.212873	1.19218	0.1229774	0.0772611	0.1884312
2004	1.238525	1.277733	1.249013	0.0538319	0.0534763	0.0476712
2005	1.306888	1.36005	1.247588	0.0551973	0.0644237	-0.0011408
2006	1.288393	1.324855	1.2874	-0.0141525	-0.0258775	0.0319116
Total Ob.	1262	385	505			

Model 3-1: National Appraisals w/o Ratio=1 Indexes (Sale Forward-looking)

App. Year	All Index	Office Index	Retail Index	Returns All	Returns Office	Returns Retail
2001	1	1	1			
2002	1.036743	1.030353	1.075995	0.0367432	0.0303527	0.075995
2003	1.094261	1.092209	1.100549	0.0554789	0.0600336	0.0228197
2004	1.252306	1.299339	1.262042	0.144431	0.1896439	0.1467387
2005	1.308375	1.302846	1.336563	0.0447727	0.0026987	0.059048
2006	1.338019	1.412785	1.334885	0.0226572	0.0843841	-0.0012555
Total Ob.	989	309	382			

Model 3-2: National Appraisals w/o Ratio=1 Indexes (Sale Backward-looking)

App. Year	All Index	Office Index	Retail Index	Returns All	Returns Office	Returns Retail
2001	1	1	1			
2002	1.042669	1.109188	1.016891	0.0426693	0.1091878	0.0168905
2003	1.15182	1.152755	1.17999	0.1046837	0.0392781	0.1603905
2004	1.239253	1.277763	1.211878	0.0759085	0.1084431	0.0270237
2005	1.284995	1.323477	1.242143	0.036911	0.0357764	0.0249741
2006	1.285611	1.367394	1.249197	0.0004793	0.0331833	0.0056787
Total Ob.	989	309	382			

Model 4: National Transactions w/o Ratio=1 Indexes(Sale)

Year	All Index	Office Index	Retail Index	Returns All	Returns Office	Returns Retail
2001	1	1	1			
2002	1.045072	1.114337	1.008999	0.0450723	0.1143371	0.0089995
2003	1.175283	1.148603	1.255557	0.1245953	0.03075	0.2443584
2004	1.230415	1.268519	1.246791	0.0469092	0.1044014	-0.0069817
2005	1.298688	1.346616	1.227666	0.0554879	0.0615659	-0.0153391
2006	1.276994	1.315517	1.270851	-0.0167044	-0.0230946	0.0351764
Total Ob.	989	309	382			