Sophisticated Sensitivity: Can Developers Guess Smarter?

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Submitted to the Center for Real Estate in Partial Fulfillment of the Requirements for the Degree of Master of Science in Real Estate Development

at the

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ABSTRACT

The commercial real estate industry is currently in a state of turmoil, as access to capital markets is as constrained as consumer demand. Today many real estate development firms find themselves in difficult positions, with plummeting net operating income and upwardly mobile capitalization rates. Tail events – market events that were believed, based on statistics, to be rare occurrences – seem to be occurring with more and more regularity. With increasing uncertainty and market volatility, the question must be asked: how well can real estate developers predict returns?

The purpose of this thesis is threefold: First, to determine whether real estate developers are accurately projecting real estate development returns; second, to determine where input assumption estimation errors are made in the ex ante proforma; and third, we undertake an analysis and application of Monte Carlo Simulation to ascertain whether, by providing practitioners another layer of transaction information, simulation is additive to the development return forecasting process.

Through the careful analysis of both ex ante and ex post proformas of real estate development projects, this thesis is one of the first to show how well developers predict the outcomes of their projects. Our findings are rather surprising.

We determine that ex ante and ex post real estate returns vary dramatically. On average expected development returns are shown to be 23.2%, while realized returns are only 9.4%. To understand this discrepancy we analyze each project proforma to identify where, during the valuation and development processes, developers made mistakes. Our findings suggest that developers are overly optimistic, especially when estimating hard costs, soft cost, and cashflow timing. The thesis results are consistent with the findings of a study by Dr. James Shilling, who analyzed the discrepancy between ex ante and ex post proforma returns for stabilized institutional properties. Shilling deduced that institutional investors are also misjudging returns, overestimating by an average of nearly 650 basis points.

We also seek to augment and improve the valuation process employed by developers by applying Monte Carlo Simulation to discounted cashflow analysis. Applying Monte Carlo Simulation to the ex ante proforma of a real development transaction, we assess whether discounted cashflow analysis coupled with simulation provides an ex ante return that more closely approximates the realized ex post return.

Again, our results are surprising. Among our findings, we learn that the simulation preparation process better informs a developer of sensitivities in input assumption variables for the transaction. However, industry data is not comprehensive, transparent, or available for a sufficiently long period of time to apply Monte Carlo Simulation. Despite the additional information provided by simulation, there remains the risk that a simulation proforma using incomplete data will yield inaccurate results.

Due to the limited sample size used in our study we acknowledge that our results must be interpreted with some caution. However, we are hopeful that this initial effort to better understand and forecast development returns will encourage further study in this important area.

Thesis Supervisor: Brian A. Ciochetti
Title: Professor of the Practice of Real Estate

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Biographical Notes

Jason J. Foster
Boston, Massachusetts
B.S. Finance, 2003, Boston College

After receiving his B.S. in Finance from Boston College, Jason began his career in Boston at Meredith & Grew, Inc., an international brokerage services firm. As an associate with the Downtown Team, he participated in a variety of transactions, and served as the group's primary analyst. After a year with Meredith & Grew, Jason left to pursue a position at Cathartes Private Investments (CPI), a boutique real estate development firm.

During his four years at CPI, Jason was involved in all phases and disciplines of real estate, across a variety of product and asset classes, including residential condominiums, apartments, hotels, self storage, commercial office, retail, and industrial. As an assistant project manager, Jason participated in the development of property throughout New England, collectively valued at approximately $250 million. Over his tenure at the firm he performed work as a project manager, asset manager, and analyst.

Bryan D. Lee
Jacksonville, Florida
BS, Finance, 2004, University of Florida

Upon graduating from the University of Florida with a Bachelor of Science in Finance, Bryan spent four years working in Jacksonville, Florida for Cantrell Real Estate, a multi-disciplinary real estate firm with appraisal, brokerage, and real estate asset management operations. His work included appraisals for development and acquisition loans, and eminent domain litigation consulting. Specifically, as co-appraiser Bryan was integrally involved with Flagler Development Company's Florida real estate portfolio, and he performed financial feasibility analysis for Codina Development's Downtown Doral development project. Independently, Bryan formed Lee Investments, LLC in 2006 to pursue mixed use, pedestrian friendly development opportunities.

Bryan is a member of Emerging Green Builders, USGBC, ICSC, and ULI Young Leaders. Prior to moving to Cambridge, he served as social chair and steering committee member for the United States Green Building Council North Florida chapter. He holds an active Florida Certified General Appraiser license, Sales Associate license, and is a LEED Accredited Professional.

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Chapter One – Introduction

1.0 Introduction

This thesis is intended to compare ex ante and ex post proforma development transaction returns. Ex ante proforma are the original, going-in deal valuations upon which the decision to execute a given transaction is often predicated. They serve to memorialize the beginning of a development transaction. Contrastingly, ex post proforma are those created once a deal has been completed to capture the history of the deal. The ex post proforma memorializes the end of the development transaction, and everything that occurred over the duration of the project, including and accurate portrayal of the timing and magnitude of all costs and revenues. Historically there has existed a discrepancy between the predicted and realized returns for a given stabilized transaction. Previous studies assess the spread in returns for operating properties of all types using a statistical comparison of the PriceWaterhouse Coopers Korpacz Investor Survey expected returns and NCREIF ex post returns.[1] However there exist no prior studies that assess development transaction returns in the same manner. In this thesis we will use disaggregated data of completed development projects as we seek to determine and diagnose any recorded discrepancy between the deterministic ex ante and ex post discounted cashflow (DCF) proformas. The first component of the thesis will focus on a quantitative comparison of the traditional DCF proformas. The second segment of the paper will assess Monte Carlo Simulation (MCS) as a complement to traditional DCF analysis and as a tool to narrow and explain the discrepancies that arise. Where MCS has experienced widespread use by corporate quantitative analysts, typically dealing in traditional assets, simulation has been largely untested as a forecasting tool for real estate development cashflows. The MCS component of the paper will have qualitative and quantitative subsections.

The quantitative analysis of the development proforma, involving basic statistics, will be complemented by qualitative data garnered from interviews with industry participants. Practitioner feedback will be used to further assess possible causes for the discrepancy in proforma returns, and industry perception of simulation.

1.1 Hypothesis

The authors hypothesize that ex post returns will vary from ex ante returns, with ex ante returns typically exceeding realized returns. Further, it is our hypothesis that the discrepancy is a result of the fact that developers typically rely on generic benchmarking and standard linear trending to build deterministic ex ante proformas. It is our experience that developers seldom reflect influencing economic factors,

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[1] Shilling, James. "Is There a Risk Premium Puzzle in Real Estate?" Real Estate Economics. December 2003. Pages 501-525.

including product supply and demand fundamentals, population growth, job growth, etc., when building proformas with static variable assumptions. We anticipate that the observed discrepancy between ex ante and ex post returns is also partially due to the inflexibility of the traditional DCF proforma.

We hypothesize that MCS analysis will yield ex ante returns more comparable to ex post returns than those ex ante returns attained using traditional DCF analysis, and that the tool will provide useful feedback as to the certainty of the returns. We expect that the data requirements for the simulation exercise will be significant, and that rigorous econometric analysis could be applied to variable inputs to refine our process. During the qualitative interview component of the thesis it is expected that articulation of the quantitative findings of the thesis will naturally highlight the possible advantages of forecasting with simulation.

1.2 Research Motivation

The thesis topic is of particular interest to the authors for a variety reasons. Initially, it is evident that there exists only limited literature on the topic, and virtually no formal study has been undertaken to assess ex ante and ex post returns for real estate development transactions. The opportunity to conduct informative research in an understudied area of the industry presents a unique challenge and will, at least, offer the authors an opportunity to satisfy intellectual curiosities relating to the evolution of qualitative and quantitative transaction valuation methodologies in real estate development.

Moreover, it is expected that conclusions can be drawn from the thesis regarding the applicability of MCS to real estate transaction analysis. In testing DCF using MCS we hope to prompt others to question and test the effectiveness of existing financial modeling techniques. The approach proposed herein, utilizing interview feedback as well as confirmed numerical data, may serve to highlight return inaccuracies born of techniques used to generate variable assumptions and return forecasts. It can then be determined whether MCS, and specifically the use of ranges for variable inputs, might serve to dampen the impact on returns of inaccurate deterministic proforma input assumptions. A developer's ability to ascertain from where returns are being impacted –revenues, expenses, etc. – will better shape investment decisions and overall transaction strategy.

We also want to understand more about simulation as a modeling tool. It is logical that previous studies may have gone unpublished because there are limitations to simulation practices that preclude it from being useful for real estate valuation. Because historical real estate data is less comprehensive and transparent than historical market data for traditional assets, we perceive that the inability to draw statistically significant conclusions about the data may also affect the utility of the tool. Besides

encouraging industry participants to consider the use of more complex tools like simulation for development transaction valuation, we would like to promote more thorough data collection practices. We anticipate that improved data collection may facilitate the evolution of real estate development valuation methodology.

Ultimately, it is conceivable that the thesis will spur additional interest in and research on the topic of return forecasting and assessment. We are hopeful that this preliminary study will grow and evolve to inspire the creation of a new development-specific PriceWaterhouse Coopers Korpacz Survey to supplement the existing survey detailing stabilized operating properties. We further hope to establish a precedent for more sophisticated valuation practices to become commonplace in real estate development. Whether using simulation or other methodology, we are optimistic that practitioners will find more accurate means for assessing real estate opportunity. The ability to better assess opportunity with this alternative asset class could result in dramatic changes to portfolio theory and allocation practices.

1.3 Overview of Methodology

We will use quantitative analysis and qualitative method to address issues posed in the 'Introduction' section regarding traditional DCF and simulation. We will conduct scripted interviews with developers to: facilitate the collection of ex ante and ex post DCF proforma; determine thought processes that informed original input assumptions for transaction variables; articulate the perception of MCS in the real estate industry. Once ex ante and ex post DCF proforma have been collected we will isolate the unlevered internal rate of return as the standard for transaction comparison. This particular return metric permits the comparison of a variety of transactions of either similar or dissimilar product type on an 'apples to apples' basis.

Another primary focus of the qualitative interviews is to help determine, for purposes of MCS scenario generation from traditional DCF proformas, appropriate ranges for the impactful variables in question. It will also be important to use feedback garnered during interviews to inform correlation coefficients assigned to each pair of tested input variables. The use of input assumption ranges for cashflow forecasting will help capture both developer intuition and randomness in the MCS proforma. As a complement to direct developer feedback, we will use existing detailed market data to inform the assignment of variable ranges, including deal-specific transaction comparables, and product-specific real estate value indices.

Once all data have been collected comparisons will be drawn between ex ante, ex post, and ex ante MCS proforma development returns. The study will illustrate current estimation errors in traditional DCF ex

ante proforma, and the utility of MCS, and flexible assumptions, to traditional DCF analysis. At a more refined level, the data will allow for the dissection of a development transaction to target specific line item discrepancies (i.e. revenues, expenses, capital expenditures, etc.) which serve to explain return forecast discrepancies. All comparative work and qualitative research is expected to yield pointed reasoning for more thorough and varied cashflow forecasting and assumption input underwriting.

Quantitative analysis will be performed in Microsoft Excel 2007, using the comprehensive simulation tool @Risk for simulation scenario generation. The add-in to Excel permits the statistical analysis of all ex ante and ex post proforma, including the application of ranges and distributions to input variables, as well as a detailed review of probabilistic returns. Discounted cashflow data transmitted in any medium aside from Excel will be translated by the authors into an Excel spreadsheet to allow for manipulation of input variable cells and simulation. All qualitative interviews and analysis will be transcribed to ensure accuracy. Permission to use interview transcriptions will be requested at the completion of each interview, and only dialogue with those participants that grant permission will be used in the thesis.

1.4 Context, Relevance, and Implications

In the recent past the industry has experienced unprecedented volatility, both a cause and effect of the worldwide credit crisis. Provided the illiquidity in the market and vastly changed lending and underwriting practices, we perceive the highlighted importance of more thorough quantitative transaction valuation practices. Considering there is minimal literature or formal study on ex ante versus ex post development transaction returns, this thesis proposes to juxtapose and compare the two, and to research the applicability and utility of MCS as a measurable additive to traditional DCF cashflow forecasting. We identify that MCS and @Risk may provide added sophistication to valuation practices, and may win popularity because of the intuitive nature of the software. Additionally, the simulation tool requires that users contemplate all influencing market factors when assigning ranges and correlation coefficients to variables. The process of blending developer intuition and documented market data in a thorough manner suggests a more cerebral method to building valuation proformas.

Because real estate transaction valuation is an unsophisticated process when compared with valuation practices employed for traditional asset classes, simulation and return assessment are seldom considered. Industry participants typically regard simulation as a purely academic exercise. Particularly provided the economic hardship, however, we believe that the thesis will find applicability in both academia and in industry. The study is relevant, given economic conditions, insofar as it helps to determine whether traditional DCF analysis, substantially used for transaction valuation, is the appropriate method by which to continue forecasting returns. MCS scenario generation will permit analysts to assess deal performance,

including flexibility and sensitivity analysis, quickly and efficiently using a variety of industry standard return parameters, including IRR, payback period, NPV, NOI, development yield, etc. Definitions of each of these return metrics are provided below:

- **Internal Rate of Return (IRR)** – IRR is a rate of return used in capital budgeting to measure and compare the profitability of investments. It is also called the discounted cash flow rate of return (DCFROR) or simply the rate of return (ROR). The term internal refers to the fact that its calculation does not incorporate environmental factors (e.g. the interest rate);[2]
- **Payback Period** – Payback period refers to the amount of time that elapses before the accumulated return of capital by an investment equals the capital outlay to undertake the investment;
- **Net Present Value (NPV)** – The total present value of a time series of cashflows. It is a standard method for using the time value of money to appraise projects that experience inflows and outflows of cash over multiple periods;
- **Net Operating Income (NOI)** – Equal to a property's yearly gross income less operating expenses. Gross income includes rental income and all other income. Operating expenses are costs incurred in the operation and general maintenance of the property, and exclude principal and interest paid to a lender, capital expenditures, depreciation, income taxes, and amortization of loan points;
- **Development Yield** – A static measure of return obtained by dividing the stabilized year NOI by total cost of the project.

More specifically, understanding which input variables substantially drive transaction returns may have implications to developers. Aside from helping assess whether current methodology is fundamentally limiting or flawed, an ability to attribute return impact to specific assumptions will have both quantitative and qualitative ramifications. Analytically, the thesis will demonstrate where developers are appropriately or inappropriately assessing transaction risks, and where more diligence in valuation may help mitigate return volatility. Careful attention will be called to the assignment of the discount rate, to input targeting, and the appropriate risk adjusted return targets. From a qualitative perspective, input considerations will offer insight into general developer process; the thesis will serve to help categorize developers as intrinsically optimistic or pessimistic, and perhaps realistic or unrealistic about transaction expectations. With the assessment of quantitative and qualitative transaction data, conclusions regarding developers and

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[2] Main, M.A. Project Economics and Decision Analysis. Volume I: Deterministic Models. Page 269.

development valuation can be drawn that might influence further study and, more interestingly, standard industry valuation practices.

In the context of existing conditions and the relative ineffectiveness of existing underwriting and valuation practices as a means of mitigating downside return volatility, the MCS component of the thesis may demonstrate why developers have previously been reluctant to embrace more sophisticated quantitative methods. A corollary focus of the thesis is to understand whether the decision to remain affixed on traditional DCF forecasting as primary means for valuation is intentional or otherwise, and whether it is done so intentionally with the knowledge of shortcomings in DCF methodology.

Another of the implications of the use of MCS in valuation is the determination by developers which economic factors should be considered when defining proforma variable ranges, and how historical cyclicality and volatility should govern distribution shaping for each variable. Critical to the usefulness of the MCS tool for refining cashflow forecasting is the ability of a user to define a range of variability, and to do so with probabilistic focus. Upper and lower limits, as well as interim values must be determined for each of the variables in order to appropriately shape the assigned distribution. Each of the defined variables, including both prescribed distribution and range, subsequently impact return distribution. This further highlights the importance of appropriately assessing input assumptions. For the quantitative components of the thesis it is important to consider the way in which macro and microeconomic factors dramatically shape performance expectations. These performance expectations can then be translated to inform distribution shape, kurtosis, and skewness:

- **Kurtosis –** Defined as the "peakedness" of the probability distribution of a real-valued random variable. Kurtosis risk denotes that observations are spread in a wider fashion than the normal distribution entails;
- **Skewness –** In probability theory and statistics, skewness is a measure of the asymmetry of a probability distribution of a real-values random variable. Skewness risk in financial modeling denotes that observations are not spread symmetrically around an average value. As a result, the average and the median can be different. Skewness risk applies to any quantitative model that relies on a symmetric distribution, such as the normal distribution.

When one considers the rarity of events that transpired from 2007 to 2009, it is important to recognize how MCS permits users to interpret and reflect this particular "crash event" risk in all future cashflow proforma. The ability to apply the influence of historical, relevant events to forecasting model inputs may revolutionize the development transaction valuation process. Developers can immediately inject randomness and historical events into deal-specific considerations for the purposes of quantifying return

uncertainty. The implications of helping traditional DCF transaction analysis evolve beyond current practice are wide-reaching and impactful for an industry poised for significant change in the near term.

Chapter Two – History and Background

2.0 Introduction to Discounted Cashflow Analysis

Discounted cashflow (DCF) analysis is a valuation method used to assess the financial viability and performance of a specific investment. Forecasts of free cashflows are generated using a combination of market knowledge, precedence, and analyst intuition, and are sometimes further defined by legal contracts.[3] Assumptions are made for revenues and expenses which, over the investment horizon, impact the resultant free cashflows generated by the investment opportunity. Where cashflows occur in future periods – often modeled at standard, regular intervals – discounted cashflow analysis involves the discounting of future free cashflows at a derived weighted average cost of capital in order to ascertain the net present value of the project. Analysts account for the time value of money through the process of discounting all cashflows back to the present.

For many real estate practitioners the weighted average cost of capital, described in corporate finance as a discount rate, draws a great deal of attention for its subjective variability amongst investors. For real estate investors the discount rate can be used to determine capitalization rate or "cap rate." The cap rate is typically defined as year one net operating income (NOI) divided by the purchase price of the asset.[4] It can be computed by dividing the property before-tax cashflow (PBTCF) by the asset purchase price. In practice the cap rate can also be calculated and defined as an appropriate risk-adjusted discount rate plus or minus a correction for estimated growth or contraction. Many real estate investors rely heavily on intuition to determine which capitalization rate should be applied to each project. Others benchmark against historical figures or against rates being used for current investment transactions, while more sophisticated users employ the fundamentals of modern portfolio theory and the Capital Asset Pricing Model (CAPM) to derive an appropriate underlying discount rate.

A primary challenge to using more complex methodology to determine the capitalization rate for a given DCF is the intrinsic uniqueness of each real estate transaction; specifically, real estate is not commoditized like more traditional equity and fixed income securities. That is to say, no one transaction is identical to another, and so to benchmark a transaction discount rate to those of ongoing transactions may be dangerous to the accuracy of the underlying valuation exercise. Additionally, the lack of

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[3] Free cashflow is a measure of financial performance calculated as operating cashflow minus capital expenditures.

[4] Net Operating Income (NOI) less Property Before-Tax Cashflows (PBTCF) typically equals money allocated to capital expenditures or reserves for capital expenditures. Often lenders will behave conservatively, computing a capitalization rate by dividing PBTCF – which includes capital expenditures – by asset purchase price. Buyers, however, often calculate the capitalization rate by dividing NOI by the asset purchase price because they feel that capital expenditures are discretionary; they are capital requirements that can be ignored, if so desired.

transparency in and infrequency of real estate transactions relative to that of publicly traded securities often can lead to errors in risk assessment and discount rate estimation.

Details of publicly traded instruments are available to all players in the public markets. Transactions involving these commoditized instruments are fully transparent to vested participants, as well as to all others who are in the market. Trade orders and documentation provide specific and accurate transaction information defining the active participants, the nominal value of the transaction, the security, and a variety of other specific details. These publicly traded securities are said to reinforce the strong/semi-strong form market, as defined by the Efficient Market Hypothesis. It is this availability of accurate information to people in both the public and private markets that separates real estate from traditional asset classes.

Details of real estate transactions, even those between publicly traded organizations, are only available to select market participants. Because of the unique nature and complexity of each transaction, active participants seldom permit the transmission of sensitive transaction information to the public markets. As a result researching relevant transaction data can be tremendously time consuming, and remains an inexact science for analysts seeking to utilize the information to inform estimates of the appropriate rates for discounting cashflows. Additionally, for many institutional investors, even data available via the National Council of Real Estate Investment Fiduciaries (NCREIF) or National Association of Real Estate Investment Trusts (NAREIT) is often insufficient or inappropriate as it is based on property appraisals, and may not capture all volatility implied by market cyclicality.

Despite the challenges associated with the appropriate assignment of a capitalization rate and/or discount rate, and with forecasting free cashflows for many years ahead, DCF remains the primary tool with which to evaluate real estate transactions. The methodology has been tried and tested for decades and is an analytical tool trusted by market participants. Further, investors and capital sources are able to easily understand the mechanics of the tool, reinforcing DCF analysis as an industry standard for transaction valuation. Moreover, the ability to manipulate variable inputs quickly for purposes of valuation adjustment and sensitivity analysis make the method particularly attractive to practitioners.

Because direct real estate investment is characterized by limited liquidity, and because ownership and maintenance of real property is capital intensive, the ability to maintain cashflow to service debt is dependent on free cashflows. Property owners and investors must therefore rely heavily on DCF as a method by which to account for the risk associated with each investment and project phase, and the associated positive or negative free cashflows. The DCF method is typically used when evaluating development opportunities because the marginal flexibility of the tool allows for analysts to best account

for variability in transaction input assumptions. Analysts can also manipulate timing forecasts, and can modify assumptions to evolve over the phases of each project, including acquisition and entitlement, construction, completion, and stabilization. Where direct capitalization or gross rent multiplication are more simplistic and may be more suitable for evaluating stabilized properties, DCF permits investment professionals to apply more complex corporate finance valuation techniques to calculate land residual value.

2.1 History of Discounted Cashflow Analysis

Discounted cashflow analysis has been used for centuries, since money was invested and borrowed with interest. The tool, as a means by which to recognize the time value of money, became more widely used in finance after the famed market crash of 1929. More specifically, Irving Fisher, author of *The Rate of Interest, The Nature of Capital and Income,* and *The Theory of Interest*, is partially credited with popularizing the methodology for valuation at a time where a scientific explanation of stock pricing and valuation was of primary interest. More substantial credit for the accurate articulation of the discounted cashflow method was given to John Burr Williams after publication of his 1938 text, *The Theory of Investment Value*. Though both Williams and Fisher demonstrated the utility of DCF as it related to stock valuation based on company free cashflow forecasts and dividend yields, the tool has enjoyed success across many industries for which aggregate cashflow valuations are critical, including the real estate industry. Without the ability to assess the financial attributes of a transaction or, as it pertains to this thesis, to value the development process, markets would seize and active trading of real property would slow or cease altogether.

2.2 Introduction to Monte Carlo Simulation

Monte Carlo Simulation is a decision-making tool that attempts to simulate a breadth of possible outcomes by including randomness in variable input assumptions. The tool permits random value generation for input assumptions, which yields a return distribution with probabilistic values to quantify and reflect the uncertainty of values of the input variables. This contrasts with traditional DCF analysis, where analysts prescribe single point estimates (for example, a point estimate of $40.00 per square foot/Year) for each input variable in the proforma. These point estimates may also be referred to as 'deterministic' variables because one must determine the value assigned to each variable. MCS, however, allows for the selection and application of ranges for each variable. The ranges applied to each of the input variables can be determined using market data, index data, and/or user intuition. In addition to these range estimates we then generate variable input distributions. MCS uses ranges and distribution inputs to generate possible transaction scenarios (as few as two and up to thousands depending user preference and

computing capacity). Iterations take into account each variable to which the user chooses to apply random selectivity, choosing an input value from within the defined range, subject to the prescribed distribution. The result is a comprehensive sensitivity analysis involving chance that tests all conceivable scenarios. As Stanford University senior researcher Sam Savage said, "What is the last thing you do before you climb on a ladder? You shake it. And that is Monte Carlo Simulation."

In mathematical terms, Monte Carlo simulation methods employ a class of computational algorithms that rely on repeated random sampling to compute results. MCS methods are often used when simulating physical and mathematical systems. Moreover, because of its reliance on repeated computation and random or pseudo-random number generation, MCS is best executed using a computer. The methodology is most often used when it is deemed unfeasible to compute exact predictive results using a deterministic algorithm.[5]

2.3 How does Monte Carlo Simulation Work?

The application of MCS may best be articulated by and understood through example. Correspondingly, we have created a hypothetical situation to illustrate the potential applicability of MCS.

Assume a real estate analyst must estimate the land residual value for a potential development project using Net Present Value (NPV) analysis. That is, he must project the magnitude and timing of expenses and revenues for the built building following completion of construction. The resulting net cashflows (revenues less expenses) are then discounted back to a present value. The difference between this calculated present value and all costs associated with the development is the project NPV, or land residual value. There are myriad variables that must be estimated in such an analysis, including but not limited to development costs, time to completion, absorption, rents, vacancy, operating expenses, etc. Traditional cashflow analysis permits an analyst to account for as many variables as he prefers, however, for ease of explanation our example will target two variables. We will vary rent and operating expenses, and will assume all else is held constant.

For a typical DCF analysis, deterministic values for rent must be estimated. While cashflows may change in the DCF from period to period, deterministic rental rates and expenses must be estimated for use in the model. Also, the analyst must make assumptions for the timing of cash inflows and outflows over the duration of the investment horizon. For example, an analyst performing DCF analysis may estimate $30.00 per square foot for Year 1 gross rental revenue, and $16.00 per square foot for Year 1 operating

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[5] Hubbard, Douglas. "How to Measure Anything: Finding the Value of Intangibles in Business." John Wiley & Sons, 2007. Page 46.

expenses, with estimates of $33.00 per square foot and $17.00 per square foot, respectively, in Year 2 and so on. Clearly, both estimates have a significant impact on projected of Net Operating Income (NOI). The impact on NOI will directly affect Net Present Value, or derived land residual.

MCS offers an alternative to the exclusive use of inflexible deterministic variable estimates. The tool allows flexibility by permitting a user to input a range for each variable. To continue with the above example, a user may input a range of rents and operating expenses. In reality, it is difficult to target one expected rental rate for a property or space. Though we may be confident but uncertain rents will be $30.00 per square foot, there is a distinct possibility that Year 1 rents may decline to $25.00 per square foot or increase to $35.00 per square foot. MCS affords an analyst the flexibility to enter a range of probable rents, perhaps $25.00 per square foot to $35.00 per square foot, in this example. Additionally, the analyst can enter a range of operating expenses of, for example, $12.00 to $20.00 per square foot.[6]

Each rental rate and/or operating expense within the prescribed range is then defined by a probability. An analyst may elect to use a normal probability distribution to define rents or expenses. MCS will allow a user to define variability using any probability distribution (binomial, discrete, gamma, logisitic, loglogistic, lognormal, etc). These probability distributions may be selected using any available public and private information, although the selection may ultimately prove difficult and subjective. When vast amounts of historical data are available the ability to effectively project probabilities and assign distributions for variables becomes much easier.

Once a probability distribution has been assigned for the two targeted variables in the proforma, the user defines the desired number of iterations run in the simulation. Monte Carlo simulation then generates the selected number of iterations, yielding a distribution of possible outputs (recall that in this example, the output variable was assigned as NPV/land residual). Predicated on the distribution of the output variable, MCS will provide the probability of each possible expected NPV.

An equally compelling example and explanation of the potential capabilities of MCS can be found in *Commercial Real Estate Analysis and Investments*, Edition 2e, by Geltner, Miller, Clayton, and Eichholtz. As described in the textbook, "If one also attaches subjective probabilities to the possible future parameters (e.g. 40.0% chance the rental growth rate will be 2.0%, 30.0% chance it will be 0.0%, and 30.0% chance it will be 4.0%, probabilities that are consistent with an expectation of 2.0% growth),

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[6] Monte Carlo Simulation allows the user to determine correlation between variables. Although a correlation coefficient will be used in the simulation exercise performed in this thesis, for the sake of simplicity we have elected to ignore correlation.

the sensitivity analysis can be expanded to a "simulation analysis" of the question of interest about the property, in which subjective (ex ante) probabilities can be attached to outcomes."

2.4 History and Application of Monte Carlo Simulation

The most famous documented early use of simulation was by Enrico Fermi in the 1930s, when he used a process involving randomness to calculate the properties of the newly-discovered neutron. The term "Monte Carlo method" was actually first used in the 1940s and 1950s by physicists working on nuclear weapon projects in the Los Alamos National Laboratory.[7] MCS was officially named after the famous Monte Carlo casino in Monaco, where physicist Stanislaw Ulam's uncle would frequently borrow money to gamble at the roulette wheels.

During the same time period scientists programmed early computers to create random combinations of known variables that could help simulate possible blast ranges of nuclear explosions. The Rand Corporation and the U.S. Air Force were two organizations responsible for funding and disseminating information on Monte Carlo methods during the mid 20th century. While experimenting they began to find a wide application for the tool in a variety of fields.

Monte Carlo simulation can be linked to pre-computing eras, though the applicability of its use was severely limited until adequate computing capacity made the process efficient.

Since its inception, MCS has been widely used in a variety of applications. Although it finds its origins in gambling and science, it can be applied whenever there is uncertainty and the potential for randomness.

Today, it is gradually becoming more widely accepted in many disciplines, as market participants become more educated on the mechanics and capabilities of simulation software. Industries that have begun to utilize MCS include:

- **Physical Sciences** – Used in computational physics, statistical physics, particle physics, and molecular modeling;
- **Design and Visual Illumination** – Used in producing 3-dimensional images, applicable in design, architecture, video games, and computer-generated films;

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[7] Metropolis, Nicholas. "The Beginning of the Monte Carlo Method." Los Alamos Science. 1987 (Special Issue). Pages 125-130.

- **Finance and Business** – Used in stochastic models for valuation of investment opportunities. MCS has been used extensively in the insurance and finance industries for valuing derivative instruments and for assessing default and crash risks;[8]
- **Telecommunications –** Used in the design of telecommunications networks, flexibility must be utilized in system design to account for variability in demand, user volume fluctuation, user location, and service preference changes;
- **Weather Forecasting** – MCS has been used in projecting catastrophic weather events, including hurricanes, tornados and earthquakes

A number of Fortune 500 firms have utilized MCS for research and analysis purposes. For example, General Motors, Procter & Gamble, and Eli Lilly use MCS to estimate both the average return to and riskiness of potential new products. Procter and Gamble uses simulation to model and optimally hedge foreign exchange risk, while Sears utilizes simulation to determine the optimal number of units of each product line that should be ordered from suppliers. Additionally, Eli Lilly uses simulation to determine optimal plant capacities for each newly-developed drug.

More recently, simulation has garnered attention on Wall Street, where firms use the tool to price complex financial derivatives. Financial planners are beginning to use MCS as well to determine optimal investment strategy and portfolio allocations for client retirement funds. More commonly in real estate, simulation can be used to value "real options," including the option to expand, contract, or postpone a project.

One of the more interesting applications of MCS is in seismology, where scientists use the method to predict earthquakes. The process is well articulated in a paper entitled, "Earthquake Loss and Risk Estimation of Buildings by Monte Carlo Simulation," written as a doctoral dissertation by Yuhong He in the Columbia University Department of Civil Engineering and Engineering Mechanics. As he describes, "The methodology of earthquake loss and risk estimation using MCS has been developed to predict probabilistic risks of buildings subject to ground motion hazard under two different assumptions including:

1. Assuming at most one earthquake in a time window;
2. Assuming an arbitrary number of earthquakes in a time window.

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[8] A stochastic process is non-deterministic. In a stochastic or random process there is indeterminacy in the process' future evolution.

The paper integrates "loss distributions conditioned on various earthquake intensity levels." The author then uses MCS to estimate damage to adjacent buildings using "damage correlation, modeled by prescribed correlation functions, and to non-adjacent buildings, subject to uncorrelated ground motions." The method is applied to estimate the aggregate loss of multiple adjacent buildings, "accounting for the interactive effects from structural and/or damage correlation in one event."[9]

2.5 Pros and Cons of Monte Carlo Simulation

After thorough review of the tenets of MCS we have assessed the pros and cons of simulation. Knowledge of the pros and cons is essential to understanding potential applicability of this tool to DCF analysis.

Phelim Boyle, in a paper entitled, "Options: A Monte Carlo Approach", presents his perception of the pros and cons of MCS. Though the paper is related to the application of MCS for stock and option valuation only, the methodology of MCS remain unchanged irrespective of the application being simulated. Boyle writes that Monte Carlo can be "simple and flexible in the sense that it can be easily modified to accommodate different processes governing the underlying stock returns. One advantage of the Monte Carlo method is that it is very flexible with regard to the distribution used to generate the returns on the underlying stock." The paper highlights an additional advantage, that MCS "has the advantage that a distribution can be used for any of the parameters of the problem rather than a point estimate. For example it may be useful in some problems to regard the variance as a probability distribution since it is usually estimated from empirical data." In summary, Boyle states that "the crude Monte Carlo approach provides a fast and flexible method of obtaining approximate answers together with confidence limits on the results."

Boyle also cites a con of Monte Carlo simulation in this paper. "One potential drawback of the method arises from the fact that the standard error of the estimate is inversely proportion to the square root of the number of simulation trials." Therefore, a large number of iterations are required to reduce the standard error and increase accuracy. Without the computing power to perform a large number of iterations for a given simulation exercise, the resulting output distribution may less accurately depict all possible outcomes.

An additional con of MCS is highlighted in *Commercial Real Estate Analysis and Investments*, Edition 2e, by Geltner, Miller, Clayton, and Eichholtz. The text states, "Our only caveat in the use of simulation

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[9] He, Yuhong. "Earthquake Loss and Risk Estimation of Buildings by Monte Carlo Simulation." Department of Civil Engineering and Engineering Mechanics. Doctoral Thesis, Columbia University. 2006.

tools is that the generation of impressive statistics based on subject probabilities and models of the relevant structural relationships (e.g. between rent growth, and expense growth and interest rates) is that they can present an *appearance* of knowing more than you actually do."

Indeed, a common criticism of MCS is that the results of simulation are only as "good" as the inputs used by the practicing analyst. Considering the myriad input variables a user can test using MCS, the risk remains that the analysis will exhibit the same limiting principles of "garbage in, garbage out" that naturally affect the accuracy of a proforma that does not employ simulation. Further, the number of input variables increases when using simulation, thus there are more opportunities for human error, poor estimation, or user bias to adversely affect output variables. Where an analyst using a traditional DCF makes point estimates for input variables, an analyst applying simulation to the same DCF proforma must now also select input probability distributions and upper and lower input value limits for the same input variables.

Related to the assignment of input variable ranges is the complaint that Monte Carlo simulation is unable to help analysts predict major economic shocks, crashes, or booms ("tail events"). Tail events denote occurrences that vastly deviate from the expected. Typically this happens when, based on statistics, a realized output value is many standard deviations above or below the mean expected output value. The greater the number of standard deviations removed from the mean, the less probable the resulting value. While MCS users claim the tool provides more meaningful projections and greater sensitivity analysis than a basic proforma, there is concern that probability distributions being used for input variables may not accurately reflect the remote possibility of catastrophe or extreme success.

The cons of MCS can be summarized as follows:

- Results of MCS may give the appearance of more knowledge than is appropriate
- Simulation is subject to the "garbage in, garbage out" theory
- MCS requires a user to generate a greater number of inputs, offering more opportunity for error and inaccuracy
- Inability to predict tail events, or major shocks or crashes

To complement our literature review regarding the pros and cons of simulation, we have interviewed real estate industry professionals to ask their thoughts about the use of the MCS for transaction valuation analysis. Their feedback, either positive or negative, indicates how simulation is perceived in an industry that is only just beginning to consider its application.

2.6 Survey of Industry Participants Regarding the Use of Monte Carlo Simulation for Real Estate Cashflow Analysis

We have discussed what MCS is, in which industries it is being used, and for what purposes. We have also detailed some perceived pros and cons of the tool, in its current state. To better isolate and detail perception of the tool in the real estate industry we interviewed real estate practitioners seeking their respective opinions about the role of simulation in real estate proforma analysis. Fourteen real estate professionals participated in the qualitative study, each from a different firm, and each employed in a different capacity. This list of real estate disciplines is representative of the diversity of interviewees:

- Private educational institution investment management

- Pension fund advisory

- Institutional U.S.-based real estate development firms

- Private equity firms

- Institutional real estate lenders

- Real estate investment management firms

- Mid-sized real estate development firms

- Real estate acquisitions and capital markets firms

- Multi-national brokerage firms

The following are a sample of the questions generally asked of the interviewees:

- Are you familiar with Monte Carlo Simulation?
- Have you used simulation in practice, and are you aware of any other firm(s) in the industry that is/are currently using the tool?
- If you are aware of another firm using simulation, which and for what purposes?
- If you are using simulation, why have you chosen to use it, for what purposes, and for how long?
- If you are not using simulation, why have you chosen not to use the tool? What are your reservations?
- After hearing about how simulation is performed, would you consider using the tool for proforma analysis? Why or why not?

- In your opinion, why hasn't the tool become popular in the industry for transaction valuation purposes?

Summaries are provided below detailing each conversation. Firm and interviewee names have been intentionally omitted to protect the privacy of the participants.

Participant 1 – Investment Management Firm

Participant 1 graduated from the MIT Center for Real Estate (MIT CRE), with a Master of Science in Real Estate Development (MSRED). The curriculum at MIT CRE involves a detailed study of MCS as applied to real estate. Therefore, he has acquired detailed knowledge of MCS and its applications to real estate, although he indicated that many employees at the investment management firm were unaware of MCS. Participant 1 indicated that MCS was generally not used in the acquisition or development process at his investment management firm because the firm does not typically engage in speculative development, for which transaction risks (and thus the perceived potential benefit of MCS) are greater. However, the firm does occasionally use MCS for drawdown schedules, which are used primarily for expense timing. Rather than use MCS as a complement to DCF for typical development proforma, the firm will explore variability in returns by performing a basic sensitivity analysis. Participant 1 indicated he found merits in the application of MCS, but also expressed hesitancy to spend the time trying to be precise with discounted cashflow analysis when precision may not be possible.

Participant 2 – Pension Fund Management Firm

Participant 2 has, over his 15+ year career, worked at Credit Suisse First Boston, Lehman Brothers, and Morgan Stanley in the real estate industry (primarily acquisitions). He now works in the real estate acquisitions department of a major United States pension fund. The pension fund is a retirement system serving nearly 500,000 active, inactive and retired public educators. Despite the complexity of the financial models used at each of the prominent firms for which he has worked, neither he nor his colleagues have heard of or used MCS for real estate valuation. Participant 2 uses sensitivity analysis, creating upside, expected, and downside scenarios as a means to assess the risk associated with expected returns of any transaction. When given a brief explanation of MCS and its potential applicability to real estate, he expressed an interest and thought the tool would be useful. He cited a lack of familiarity with MCS as a reason for not using the tool, and suggested this might be the reason others in the industry have not taken to simulation.

Participant 3 – International Development Firm

Participant 3 works as a Project Manager for an international development firm, and has a strong understanding of MCS. His knowledge of simulation was accumulated via formal institutional education, and previous professional experience. He does not currently use MCS in any capacity, citing a lack of need for the tool. He gave several additional reasons why neither he nor his firm use MCS. First, he offered that the process of applying the tool to the DCF template for valuation requires too much time required and is extremely complex. As well, the interviewee stated that he believes it is inappropriate to attempt precision when making certain input assumptions for which precision is impossible. No suggestions were offered as to which variables preclude the use of simulation or which might benefit from the use of simulation. Further, Participant 3 said that data in the real estate market is not as transparent as it is in the stock market. He believes that it is this lack of transparency that makes it difficult to accurately assign correlation coefficients between input variables.

Participant 4 – International Private Equity Firm

Participant 4, a PhD, hesitates to use MCS in her role as Managing Director for Risk Management at a major private equity firm because she is concerned that the utility of such a tool is only as good as the predefined simulation parameters. Participant 4 indicated that MCS requires a probability distribution assigned to certain variables, effectively limiting the variables by applying upper and lower bounds. She further states that the volatility and tail event of the past several months tells her that possibility of an extraordinary event occurring is necessarily remote, and that sole reliance on MCS may actually impair or limit decision-making. Participant 4 believes that too few truly understand MCS at this time for it ever to become commonplace in real estate valuation practice.

Participant 5 – Commercial Lender at Domestic Bank

Participant 5, in his role in the corporate banking department of a large domestic commercial bank, has not used MCS, nor had he heard of simulation. He was altogether unfamiliar with the tool, but after discussion of the premise and methodology of simulation Participant 5 recognized how simulation and the application of ranges and distributions could be useful for the valuation of both stabilized properties and development transactions.

Participant 6 – Investment Advisory Firm

Participant 6 has never come across MCS at all during his career. He stated that his investment advisory firm is driven primarily by IRR in its decision-making, and that he believes in the relative accuracy and

simplicity of DCF for transaction valuation. A primary reason the firm has not considered MCS is that its clients, primarily pension fund investors, have not requested MCS as a tool to be used to influence the firm's decision-making process. Effectively, unless clients become comfortable with simulation and specifically request that it be used, it is unlikely that the firm would consider deviating from current valuation practice. Upon hearing a brief explanation of MCS, he expressed concern about the fact that the outcome of MCS is dependent on input variable distributions selected by the user. Without a scientific method of generating appropriate range estimates and distribution curves the simulation might yield an entirely inaccurate forecast. They have not seen a need for the tool, do not anticipate seeing a need, and suspect that other firms, particularly those that answer to institutional capital sources, will not either.

Participant 7 – International Investment Management Firm

Participant 7, a PhD, is the Global Strategist for a major international investment management and brokerage firm. He has a very strong understanding of MCS and its application to the real estate transaction valuation. He cited several reasons his firm does not use the tool on a regular basis, including:

- Clients do not ask for it

- Clients' lack of understanding of MCS

- Stakeholders on the 'deal level' find it easier not to "live in the world of probabilistic or stochastic returns"

- Business needs to work within the world of point estimates, not ranges, because point estimates represent the prices at which you buy or prices at which you sell; they are definitive and purposeful

- Upside and downside point estimates (traditional, or typical sensitivity analysis) are more intuitive than multiple iterations with MCS

- Basic sensitivity analysis and 'what-if' scenarios are more understandable to most people than scatter plots

- General ignorance and lack of education

- There is a decision-maker bias to get to the decision quicker. Data needs to be quickly absorbed and understood, and MCS does not hasten process

- The name 'Monte Carlo' implies gambling and the firm does not want this stigma associated with its investment decisions

Participant 7 indicated that the firm will occasionally use MCS, however only on rare occasions. He stated that even when they do use the tool, they do so internally and do not explain to clients what they are doing. A general lack of understanding on the client side may lead to substantial confusion, and the information overload would not help but hurt relationships. He stressed that even if the firm were to inform clients of occasional MCS use, it would never refer to the tool as 'Monte Carlo Simulation' because the name inevitably connotes gambling to those who are unfamiliar with simulation. Finally, he said there might be a greater applicability for MCS in portfolio management to estimate the ranges of outcomes for a particular asset class, but never on an individual property-level deal basis because of the uniqueness of each transaction.

Participant 8 – International Financial Services Firm

Participant 8 is Vice President of Real Estate and Infrastructure for a leading international financial services firm. He was vaguely familiar with MCS, but does not use it in his work. Upon a more detailed explanation of MCS, he said that he did not believe the tool would be particularly useful in his current role however he thought it may find more applicability in the acquisitions or research departments at the firm.

Participant 9 – Development Firm

Participant 9 indicated that he had never heard of, nor used, MCS in his role at the development firm for which he works. After a brief explanation of MCS, he indicated that he thought it would be a very useful tool for validation purposes in addition to the traditional DCF and sensitivity analysis, but that it would likely not fundamentally change the way the firm evaluates transactions. The interviewee stated that he believes developers generally make decisions based predominantly on intuition. He further states that often a developer will assess whether an opportunity is appealing, and will then generate a proforma that supports intuition. He indicated that at his firm the investment team generates an investment strategy, targets opportunity, then performs basic static financial analysis to support the thesis.

When asked why the industry has been slow to consider using MCS as a complement to DCF, he responded that he believes that real estate developers are not very sophisticated, and that there exists a 'knowledge gap' regarding MCS. He was also concerned that the lack of transparency in real estate industry data might preclude the use of MCS, and the tool may have more applicability in financial modeling for investment opportunities for which there is substantial historical data for benchmarking, and

market timing. Additionally, Participant 9 said that MCS may be too time-consuming considering the limited window of opportunity afforded an investor between the time a property is targeted and acquired. Finally, he indicated that MCS might be more applicable to real estate portfolio management than to individual deal valuation.

Participant 10 – Development Firm

Participant 10 has heard of Monte Carlo simulation, but indicated that the tool is not currently used at the development firm for which he works. He believes that the industry standard for project valuation has been and will likely remain Argus. The participant indicated an interest in simulation, but was convinced that the tool would only be of use to a distinct segment of the industry; portfolio managers responsible for substantial and diverse real estate investment. On the contrary, he stated his belief that if you work for a private, entrepreneurial development firm, most important investment decisions start with back-of-the-envelope analysis, and thereafter the financial analysis never gets complicated enough to warrant the use of a sophisticated tool like simulation.

Participant 11 – Commercial Lender

Survey Participant 11 is a Senior Vice President at a large commercial lending institution based in the Midwest United States. The participant indicated that although he had heard of MCS, to the best of his knowledge none of the divisions within his firm use MCS. He believes that there is a lack of sophistication in most underwriting performed by development firms, and some lenders. Historically, his firm performs DCF analysis for each targeted investment opportunity, and then performs sensitivity analysis on different variables, including interest rates, occupancy levels, rental rates, capitalization rates, and debt service coverage ratios. When asked if he thought MCS might be useful to select professionals in the real estate industry, he indicated that simulation could be appealing to underwriters if made readily available and cost effective. If both criteria were met, and it were proven as an effective valuation tool, the interviewee believes banks would all, eventually, would progress to include the tool as part of the underwriting model. Participant 11 said that the improved quality and depth of information generated using simulation is what would be attractive to the bank, and MCS is something that he believes the real estate investment profession will need as data becomes more robust and comprehensive.

Participant 12 – Real Estate Consulting and Advisory Firm

Participant 12 is well aware of MCS, and with how to use the tool for valuation practices. However, he does not use the tool in his role as a Senior Consultant. He reasons that there is a knowledge gap between practitioners and clients, and simulation reporting detail makes it difficult for a professional to present the

material to clients in an easily understood format. More importantly, clients do not request the use of the simulation tool in his firm's investment analysis, so he feels little pressure to modify methodology without reason.

Participant 13 – Real Estate Acquisitions, Development, and Operation Firm

A graduate of the MIT Center for Real Estate, Participant 13 knows a great deal about MCS, however, he does not use it for underwriting real estate acquisitions or development. He states that analysts at the firm for which he works create numerous different iterations as a sensitivity analysis. By the time the acquisitions team is prepared to go to the investment committee with a proposal, it is well aware of key variables for the transaction that most dramatically impact returns. He believes it would be difficult to explain to his investment committee the information the simulation tool was providing. Moreover, the participant was certain that members of his investment committee might consider simulation results to be "fluff," and would instead ask only for what the acquisitions team was certain needed to be considered to understand the transaction in question.

Participant 14 – Multi-national Brokerage Firm

Participant 14, a leasing and investment sales broker for a multi-national brokerage firm, is familiar with MCS. Further, he is aware of the mechanics of the tool, specifically the application of ranges and distributions for all tested variables, but was unclear about the importance or relevance of assigning correlation coefficients between variables. The participant recognized how simulation provides investors with a more comprehensive sensitivity analysis, and knows how to interpret the output distributions that result from a simulation exercise. The interviewee has never used MCS, but has been given results tabulations and graphs by his financial advisor to inform portfolio allocation decisions for personal accounts.

Though he has never used simulation as a real estate professional, he would consider using it in the future and believes it will come to be highly regarded in the industry. The interviewee was unsure why acquisitions teams are not more interested in the tool considering the possible benefits, and believes the reason it has not yet become valuation protocol may be analyst uncertainty or laziness. He offered that while most point estimates for variables are often incorrect, sometimes substantially so, real estate professionals should be willing to consider any additive tool that might improve valuation accuracy.

2.7 Survey Analysis

In this section of the paper we will summarize all qualitative interviews, and have quantified the results in order to illustrate industry knowledge of MCS, as determined from the interviews. Of all interview participants, 28.6% stated that they were not familiar with simulation, while 71.4% indicated an understanding of the simulation tool. More importantly, perhaps, of those who were familiar with MCS, 100.0% do not use the tool on a regular basis, and only 21.4% have ever executed a simulation. For those who had executed a simulation, 0.0% used the simulation tool as an additive component to a DCF valuation analysis. We also record that 35.7% of interview participants who had no prior knowledge of MCS indicated an interest in the tool, and could envision using simulation in their current role.

These numbers generally coincide with past research papers on the applicability and industry acceptance of various real estate modeling techniques. In a paper entitled, "A Re-Examination of Real Estate Investment Decision-Making Practices," based on qualitative interviews with real estate industry participants, Farragher and Kleiman found that, "formal quantitative risk analysis is required by only one-third of the respondents, with sensitivity analysis, scenario analysis, and high-average-low forecasting being the preferred tools."[10] The paper also concludes that "the most popular evaluation measures are the discounted cashflow measures, which are required by 68% of the respondents."

In summary, it is evident that MCS is not widely used in the real estate industry for transaction valuation. Based on our interviews, all respondents use some form of DCF analysis to underwrite transactions and, ultimately, to estimate expected returns. Generally, those that use DCF analysis use a tiered "high-average-low" sensitivity analysis to determine potential upside and downside when underwriting an opportunity.

The "high" scenario reflects aggressive and favorable changes to impactful proforma input variables that collectively yield a strong return that exceeds what is truly expected by the firm. The "low" scenario runs in opposition to the "high" scenario, and instead all impactful variables are adjusted to yield a poor return that falls well short of the average expected return. Logically, the "average" scenario employs moderate input variable point estimates to generate the actual return the firm expects to receive by investing in the project.

We also conclude that approximately half of those interviewed knew of MCS prior to our discussion. Of those with prior knowledge of MCS, none believed that the tool could be imminently useful in the

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[10] Farragher, Edward and Robert T. Kleiman. "A Re-Examination of Real Estate Investment Decision-making Practices." Journal of Real Estate Portfolio Management. Volume 2:1. 1996. Pages 31-49.

valuation of individual transactions. Primary concerns of interviewees about the use of simulation, and common reasons simulation is not used in practice are summarized below:

- Lack of knowledge of MCS as a simulation tool;

- Lack of pressure from clients and peers to use the tool;

- Limited timeframe in which to execute a transaction;

- Lack of transparent data for accurate use during simulation, including correlation coefficients determination, range assignment, and distribution selection for input variables;

- Name 'Monte Carlo' implies gambling, which is an inappropriate way to articulate analytical investment tools being used for transaction valuation

Chapter Three – Literature Review

3.0 Overview

During our review of existing published material, we sought literature discussing three distinct topics:

1. The comparison between disaggregate ex ante and ex post development proforma;
2. The study of MCS as a tool for valuation of disaggregated real estate transactions;
3. Real estate cyclicality

The literature detailing MCS and the comparison of ex ante and ex post proforma was sought during our exploration of existing research to help build the framework and fabric of the thesis. It is important to recognize what has been articulated in existing studies, and to determine where opportunity exists to add to industry knowledge base. Literature detailing the real estate cycle was sought as a corollary to the MCS literature, specifically to inform assignment of input variable assumptions for the simulation exercise detailed later in the paper. Understanding cycles and recognition of the importance of timing to transaction execution was the underlying focus of this component of the literature review. Particular attention was paid to cycle length and volatility.

There is no existing literature comparing ex ante and ex post real estate development transaction returns. Moreover, after exhaustive investigation we were able to uncover only a small number of studies that assess ex ante and ex post returns on stabilized operating properties. Many market participants, operating at an institutional level or otherwise, are guarded about detailed transaction financial information, and it remains a challenge for academic researchers to source sufficient high quality data for study. In the absence of substantial transaction data, collected over a long time series, it is near impossible for anyone to draw statistically significant conclusions about discrepancies between ex ante and ex post real estate returns.

Additionally, there are few academic papers that explore MCS as a tool for use in real estate development transaction valuation. Simulation tools have been primarily used in the real estate industry for the valuation of real options, and much of the associated literature stems directly or indirectly from work by Professor David Geltner, of MIT Center for Real Estate. Substantial literature was found detailing the use of simulation as an investment analysis tool in quantitative corporate finance, where analysts seek to model uncertainty in returns of traditional assets. Our literature review yielded background information on the fundamental execution of MCS, and on the mechanics of option valuation, both real and financial. Aside from financial option valuation, some large institutional banks have also employed simulation to model and forecast default probabilities for loan pools. For active participants in the pooling and

syndication of loans, the complicated assumption inputs for valuation and default models are being reconsidered in light of the current condition of secondary market. We were unable to find literature detailing the ways in which variable input assumptions for default calculation models are changing to reflect conditions, however expect it might become a much-studied topic. An aside, during the review we discovered substantial literature detailing the use of simulation for a variety of other applications. Among them was stock price modeling, weather forecasting, gaming, oil drilling, portfolio optimization, medical imaging device improvement, etc.

3.1 Comparison of Ex Ante and Ex Post Real Estate Returns

In 2003 an academic paper was published by James Shilling, a professor of real estate studies at DePaul University, entitled "Is There a Risk Premium Puzzle in Real Estate?" The paper explores the discrepancies that have arisen, historically, between ex ante and ex post returns to stabilized institutional properties. This is regarded as the first paper of its kind. The analysis considers ex ante returns as reported to the PriceWaterhouse Coopers Korpacz Investor Survey, against recorded disaggregate returns illustrated by the National Council of Real Estate Investment Fiduciaries (NCREIF). One conclusion drawn from Shilling's work is the implication, over a 15 year time frame, of a noticeable lack of variability in expected ex ante real estate investment returns. The static estimates of ex ante returns across product types indicate a fundamental disconnect between real risk incurred and the requisite corresponding reward for real estate investors bearing the risk.

The paper discusses how return premium, which has gone unchanged over the considered horizon, for investment in real estate exceeds that which can be explained with economic modeling. This suggests that real estate investors have substantially ignored the effects of cyclicality and influencing economic factors when targeting acceptable returns for real estate investment. That is to say, as risk associated with, for example, multifamily properties has varied over time subject to fundamentals like income levels, employment, population, etc., developers have inexplicably required the same rate of return over the test period.

Ultimately the paper does well to articulate the spread, and root causes for the spread, between institutional ex ante and ex post real estate returns to stabilized property. The data set is constrained in that it spans only 15 years, however the number of data points is sufficient to draw statistically significant conclusions. The author indicates a willingness to continue the study with a larger data set as time passes. The paper differs from the thesis in that it only compares returns for stabilized assets, and excludes development transactions over the time period.

In "A Structured Model Approach to Estimating Return and Volatility for Commercial Real Estate," a paper written by Ciochetti, Fisher, and Gao in 2003, the authors explore the generation of a model to estimate ex ante risk and return. Using disaggregate NCREIF data, which eliminates the use of appraisal techniques to mitigate the effects of smoothing, the authors then assess ex ante commercial real estate returns and ex post returns. The results of the study suggest that the use of a structured model to generate the estimates for performance and volatility of commercial real estate may be a viable alternative to techniques currently in use in academic literature.[11] The authors test the applicability of the model by comparing "portfolio" returns to an assemblage of disaggregate stabilized ex ante deals, as indicated by the model, to the ex post return to the same portfolio.

The paper concludes that, based upon model results using data stratified by type and location, ex ante returns were generally found to exceed ex post realized returns. As sample size increases, the authors also conclude that the spread between expected and realized returns is maintained, and that the standard deviation of expected returns decreases.[12] The results of the paper are important for two reasons:

- A tested model exists to help forecast real estate returns;
- It was tested and proven that, with statistically significant conclusiveness, a discrepancy exists between expected and realize real estate investment returns

While the paper defines an economic model for more accurately estimating risk and return, the study focuses on stabilized properties rather than development transactions.

3.2 Simulation

In a paper entitled "Monte Carlo Simulations for Real Estate Valuations," published by the International Center for Financial Asset Management and Engineering in its FAME Research Paper Series, Martin Hoesli, Elion Jani, André Bender explore simulation with the Adjusted Present Value (APV) method. The simulation distributions are construction using various data from the Swiss financial and real estate markets, and the empirical analysis is performed using an institutional portfolio of 30 properties located in Geneva.[13] Value of the underlying asset is required to calculate the discount rate for the analysis:

- The discount rate is assumed to be constant during the entire holding period;
- Uncertainty is not explicitly taken into account

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[11] Ciochetti, Brian A. and Jeffery Fisher and Bin Gao. "A Structured Model Approach to Estimating Return and Volatility for Commercial Real Estate." March 2003.

[12] *See Footnote 11.*

[13] Hoesli, Martin and Elion Jani and André Bender. "Monte Carlo Simulations for Real Estate Valuations." FAME Research Paper. June 2005.

In the paper the APV method is used to determine the net present value of an asset, if the asset is financed purely with equity, and then subsequently to determine the net present value of all benefits of financing, including the valuation of interest and depreciation tax shields. The method, an alternative to discounted cashflow analysis using Weighted Average Cost of Capital, provides the ability for an investor/developer to parse value to better understand the impact of debt financing on a project.

A qualitative consideration of the paper and of APV is the added direct value of leverage as measured against the corresponding imposed challenges of financial distress. The study uses empirical data, specifically with variability in discount rates, to determine probability distributions of returns. When using the APV method, free cashflows are discounted at the unlevered cost of equity, while the tax shields are discounted at the cost of debt. The discount rate derivation is particularly important to the valuation of property, where the authors used a traditional term structure model and applied a premium to adjust for risk to the real estate. The risk premia are typically determined from comparables, or "pure plays" - transactions that are largely similar to those being evaluated.

One contribution of the paper is in incorporating uncertainty in the valuation process. The use of input variable ranges rather than deterministic point estimates clearly articulates the authors' primary concern with traditional DCF; the inflexibility of variable inputs unnaturally affects the output variable value. The paper also highlights two other perceived limitations of DCF analysis, and develops methods to remedy each of these issues:

- A method to estimate the discount rate which does not require prior knowledge of a property's value is defined and articulated;
- The analysis utilizes a time-varying discount rate

The paper establishes a precedent for both questioning the DCF process, and utilizing simulation as an additive tool with which to build uncertainty into the valuation model. The paper differs from the thesis in that the simulation exercise is performed on the 30 properties assembled as a portfolio rather than on a disaggregated basis. Also, the model tests variability specifically in long term interest rates, as it translates to discount rate, and terminal cap rate. Our simulation exercise tests uncertainty in a different pair of input variables to assess affect on returns. The authors' use of the APV as the output variable also differs from the output variable selected for the simulation performed in the thesis.

In 2006 Michel Baroni, Fabrice Barthélémy, and Mahdi Mokrane published, "Monte Carlo Simulations Versus DCF in Real Estate Portfolio Valuation," in the ESSEC Working Papers. The paper considers the use of Monte Carlo simulation as a tool with which to generate complex cashflows for real estate assets in

order to derive a return distribution. Important simulation inputs are provided by results on real estate indices for Paris that are derived from an earlier article by the same authors. The paper suggests, based on analysis of a residential real estate portfolio, that simulation of cashflows from a real estate asset better considers all of the risks associated with those cashflows than traditional DCF. The authors believe that the stochastic process is a better means for reflecting uncertainty in volatile, impactful variables that the closed form formulae used for most traditional DCF analyses.

The authors also contend that the exercise would allow investors a chance to generate a price distribution for any horizon, as well as allowing for Values at Risk computation (VaR). VaR, discussed in detail in "Sensitivity Analysis of Values at Risk," written by Gourieroux, Scaillet, and Laurent in 2000, is a tool used by many financial institutions for risk management. Per Baroni, Barthelemy, and Mokrane, the VaR measures the maximal loss possible during a given time period under normal conditions, and for a given confidence interval.[14] Below is an example of a VaR graphic:
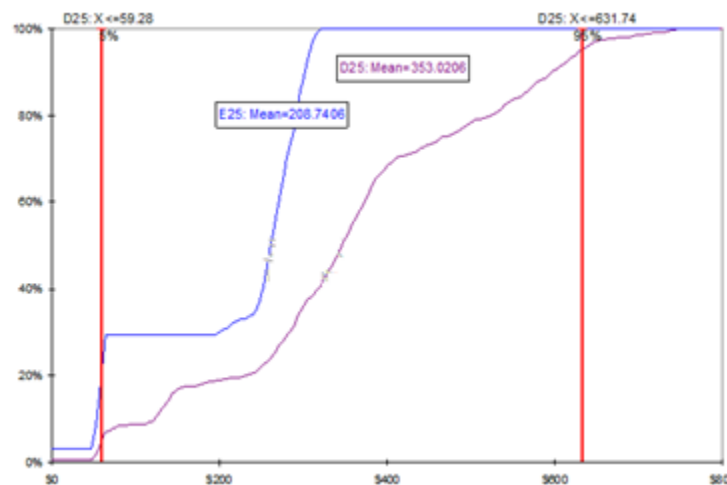
Figure 3.1

The vertical lines, running parallel to the Y-axis, indicate the bounds of the 90.0% confidence interval for the associated analysis. The jagged diagonal lines indicate the values at risk for two different investments. An analyst would quickly interpret the graph such that there is a 90.0% chance, based on the simulation exercise, that the value returned by the asset will fall between the nominal values indicated on the X-axis.

The portfolio valuation exercise articulated in the paper is performed in two distinct manners, first using DCF and then with simulation. The input variables are many, with two variables directly affecting revenues, two directly affecting expenses, and the last being directly associated with terminal value. The

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[14] Baroni, Michel and Fabrice Barthélémy and Mahdi Mokrane. "Monte Carlo Simulations Versus DCF in Real Estate Portfolio Valuation." ESSEC Working Paper. 2006.

results of the two valuation techniques are compared, including annual assessments of free cash flows, as well as terminal value. The comparison concludes with a discussion of the authors' perceptions of the weaknesses of DCF analysis. Additionally, the authors restate the thesis that simulation yields better and more comprehensive results by more accurately reflecting the risks associated with cash inflows and outflows.

The paper is helpful to establishing the use of simulation as an alternative to the DCF method. The paper differs from this thesis insofar as it elects to test a different subset of input variables, and that it assess simulation on a portfolio of existing properties rather than on disaggregated development transactions. Moreover, where the methodology proposed herein is largely predicated on qualitative interpretations of discussions with developers, Baroni, Barthélémy and Mokrane are quick to point out that successful preparation and interpretation of their simulation process requires sufficient knowledge of the statistics laws that govern the variables used to generate estimates of free cashflows.

3.3 Real Estate Market Cyclicality

The third relevant topic considered during the literature review is the real estate cycle. In an article entitled, "Predictability of Real Estate Returns and Market Timing," published in the Journal of Real Estate Finance and Economics (1994) by Jianping Mei and Crocker. H. Liu, the authors explore the predictability of real estate returns. The article also focuses on investors' ability to exploit these predictable real estate returns using various timing strategies, based on documented cyclicality in the real estate market. Given predictability, the argument is made against long term buy and hold strategies in favor of more liquid short term real estate investment. The authors detail the strong risk-adjusted excess returns to real estate-based stocks against those to large or small stocks, or bonds; this is particularly interesting provided similarities between real estate-based equity securities and the other instruments.

Ultimately, the paper concludes that there is evidence supporting the use of market timing strategy for investment in real estate to exploit predictability, permit the investor to realize superior performance over buy and hold strategy, and realize excess asset returns for a prolonged period of time. The paper is effective in articulating the importance of recognizing cyclicality and predictability in real estate markets. The authors demonstrate that excess returns and predictability of real estate make real estate investment an attractive alternative to traditional assets.

The paper explores a vastly different topic, focusing entirely on exchange-traded real estate securities and REIT data for the analysis. Real estate is parsed into a few categories, including EREITS, builders, owners, and mortgagers, and value weighted portfolios were created as a proxy for each subgroup. While

the analysis and premise of the paper do not coincide with those of this thesis, we again highlight the importance of the paper in establishing the relevance of cyclicality.

Cyclicality was also studied extensively in an article entitled, "The Present Value Model with Time-Varying Discount Rates: Implications for Commercial Property Valuation and Investment Decisions," by David Geltner and Jianping Mei, published in 1995 in the Journal of Real Estate Finance and Economics. In the paper the authors explore the private real estate market, and create an autoregressive model to predict cashflow and real estate returns. The study then focuses on using the forecasting model for two distinct purposes:

- To create a revised present value model that accounts for cyclicality as a means to more accurate forecast expected real estate returns;
- To develop a simple buy/sell rule triggers off of the identification of market peaks and troughs[15]

The study focuses on time sensitivity of real estate returns, and specifically on the identification of inflection points in the overall market. At such critical points, where the market officially changes trend direction, a sophisticated investor may take advantage of the cyclicality with acquisition and disposition timing.

While this study does not consider simulation, the implication of observed cyclicality in the real estate markets may help define variable range assumptions, as well as distribution shape and characteristics. The paper focuses on the private markets, which is consistent with the thesis of this paper, however the buy/sell strategy resulting from the predictive model findings is intended to focus the efforts of investors on stabilized property rather than on development opportunities.

The final paper of particular relevance to this thesis is, "Real Estate Business Cycles: Henry George's Theory of the Trade Cycle," by Fred E. Foldvary. The paper, written in 1991, discusses the relationship between real estate cycles and business cycles. Specifically, the author explores cyclicality of real estate markets as a leading indicator of economic prosperity or recession. The author restates George's theory that, "the effects of real estate have not been a pure market activity, but have been influenced by

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[15] Geltner, David and Jianping Mei. "The Present Value Model with Time-Varying Discount Rates: Implications for Commercial Property Valuation and Investment Decisions." Journal of Real Estate Finance & Economics. Volume 11. 1995. Pages 119-135.

significant government fiscal and monetary interventions," and so it is important to give consideration to all economic activity when determining estimates of cycle length and magnitude.[16]

The paper continues by discussing each of the short and long cycles witness in real estate. Evidence supports cycles of a few as 2-3 year, and as many as 100 years, and each is discussed as it translates to overall economic conditions. The component of the paper focused on real estate cycle history isolates a number of different recurring trends in real estate market cyclicality, and reinforces the belief that the benchmark for the typical real estate cycle remains 14 to 18 years from trough to trough. The author states, "Whereas the smaller and more frequent business cycles may be due to random shocks or non-real-estate causes, the larger real estate cycles have exhibited similar patterns and, historically, have occurred in regular intervals."

Though the primary focus of the paper is to establish the interconnectivity of the real estate market and the overall market, the paper cites empirical data in concluding that over the course of history all real estate market booms have immediately preceded economic recession, and that the magnitude of each rise and fall are somewhat subject to interpretation. The isolation of the 14 to 18 year trend is important to our thesis in that it provides a standard benchmark, without requiring significant econometric analysis, for evaluating cycle length and relative position in the cycle.

3.4 Literature Review Conclusion

We uncovered a great deal of literature on each of our three research sub-topics detailed in this chapter, however would certainly like to recognize that other papers exist that support and cite each that we have outlined. These particular publications were considered, at our discretion, to be most representative of the existing body of work surrounding our thesis topic, and the most relevant to addressing questions we had as we formulated our hypothesis and process. The three subsections in this chapter are all current, and are focused on topics that serve as the foundation for our both the comparison of ex ante and ex post proforma, as well as the MCS exercise using DCF analysis. Our approach to the analysis conducted in this thesis is, to the best of our knowledge, original and we are hopeful that it is contributory to the exploration of the roles of DCF and MCS in real estate development transaction valuation.

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[16] Foldvary, Fred E. "Real Estate and Business Cycles: Henry George's Theory of the Trade Cycle." Lafayette College, Henry George Conference Speech. June 1999.

Chapter Four – Ex Ante and Ex Post Comparison Methodology

4.0 Ex Ante and Ex Post Analysis Methodology

We gathered data from a variety of real estate developers in order to compare potential differences between ex ante IRR projections and ex post IRR results for eight real estate development deals. We take this opportunity to state that we uncovered no qualitative or quantitative research, on a large scale, that provides this development data the same way the Korpacz Real Estate Investor Survey (published quarterly) provides data for stabilized real estate properties. The data analyzed in this thesis was collected directly from each of the authors' professional and personal industry contacts. Requests for data were made during personal meetings and telephone conversations over a period of approximately two months.

Finally, we made assurances that all firm names, individual names, and project locations would be masked. It was important to obscure the data to prevent the release of sensitive transaction information, and to protect the privacy of all transaction participants. Correspondingly, for each analyzed development transaction we made certain to identify generally location for reader perspective (urban area, suburb, CBD, etc.), but have omitted project names, addresses, and all other specific information.

4.1 Ex Ante and Ex Post Proformas

Real estate developers were asked to provide two proforma: ex ante and ex post. Developers were also asked not to intentionally select transactions that were either particularly successful or unsuccessful, but rather to randomly choose from all completed development transactions. All participating firms average 25 years of relevant development experience.

Each of the real estate developers that provided data was located in New England. Resultantly, all but one of the development deals for which ex ante and ex post proforma received was located in New England. Though geographically similar, some projects are located in central business districts of major cities, while others are located in secondary or tertiary cities, or in the suburbs.

While all development transactions began and concluded during the last market cycle, commencement and completion dates vary between projects. One transaction, beginning earliest of all, commenced during the third quarter of 2000. All other ex ante proforma begin on or between Q1 2004 and Q4 2006. All ex post proforma completion dates range between Q4 2001 and Q2 2009, with most transaction concluding in 2006 and 2007.

We targeted the ex ante proformas that marked the commencement of each development transaction. For purposes of the thesis, commencement is defined as the point in time at which the official decision was

made by the developer to proceed with the transaction. In a typical development scenario, multiple proformas are created over the life of a project to reflect market dynamics and input variable changes. Because development projects are never static, proformas evolve to afford the developer updated snapshots of the transaction over time.

Additionally, for each transaction different ex ante development proformas are created for the parties involved in the transaction. For example, one ex ante proforma may be created specifically for a senior debt lender, while an alternate ex ante proforma, perhaps highlighting other transaction issues or measures, may be created for a mezzanine capital lender. Often there is a distinct difference between all proforma built for external distribution, and those built for internal use. The developer's internal proformas typically reflect additional layers of transaction detail used to inform decision-making and strategy. The information may include partnership proceeds splits, payout waterfall detail, or even modified input variable assumptions.

Because the developers provided many proforma iterations for each development transaction, we were sure to confirm our proforma selections during the interview process to be certain we had chosen the two proforma that memorialize the beginning and end of each transaction. All selected ex ante proformas were internal developer proformas.

Information was provided in Microsoft Excel format to ensure that all original formulae and input assumption values were transparent. Proformas included all anticipated cash inflows and outflows projected for the duration of the development period until stabilization is reached. Stabilization is defined as time to total sellout for a for-sale product (i.e. condominiums), or time to steady occupancy and revenue growth (i.e. office, hotel, industrial, etc.). Cashflows were generally comprised of, but not limited to, the following line items:

- Hard Costs
- Soft Costs
- Gross Rental Income
- Absorption Period
- Vacancy Projections

- Operating Expenses
- Capital Expenditures
- Reversion (Sales) Prices
- Transaction Expenses

Developers also provided ex post results for each real estate development transaction. The ex post proformas were requested in Microsoft Excel format to maintain transparency, and to facilitate comparison to corresponding ex ante proforma. Ex post proformas included similar line items to those listed in the ex ante proformas.

4.2 Development Transaction Returns, Data and Process

The standard of comparison between ex ante and ex post proforma was transaction IRR. Transaction IRR is defined as the return to the project from commencement, through construction, up to and including the date of stabilization. All ex ante proforma cashflow occurring after stabilization was excluded from the IRR calculation. For all ex ante proforma, the date of stabilization was targeted by the developer as the date of disposition, or recapitalization. Cashflow realized after stabilization would clearly affect transaction IRR, and would prevent us from isolating and comparing returns from only the development phase of the projects.

All transactions for which data was received can be classified as one of only two product types: for-sale residential condominiums; and hotels. Although we would have preferred a substantial and diverse data set, including a wider variety of property types, the amount of available quality data was limited. Many developers refused to release sensitive transaction data for research. Others kept only limited transaction data, or data that was insufficiently detailed for purposes of comparison. Many developers, in fact, did little more than use Excel to illustrate a back-of-the-envelope analysis. In this regard, we restate that one purpose of the thesis is to examine developer methodology using DCF analysis. Specifically, we wish to explore how deterministic input assumptions are generated for ex ante return analysis, and ex post results differ from ex ante projections. Regardless of product type, a common thread between each of the eight development transactions for which data was collected is that each was underwritten using DCF, and each yielded an IRR measurement. Thus, developer process and projection accuracy could be assessed irrespective of product type.

Once data was gathered from developers, we arranged all proformas in a similar format so ex ante and ex post proformas for individual transactions could be easily compared. A side-by-side comparison was conducted to assess whether a difference existed between projected and realized costs, revenues, and returns. Equity unlevered IRR was used as the compared output return metric because it is reflective of the time value of money. The equity unlevered IRR, measured from property level cashflows before taxes, also helps avoid wrestling with intricate and unique capital structures to determine levered returns. By avoiding leverage, unlevered transaction IRR can be compared between investments on an 'apples to apples' basis. Because of the limited amount of available data, and partly because each deal is unique in nature, conclusions are not statistically significant. The conclusions, however, may illustrate fundamental trends in development transaction analysis, and similarities in method between different developers. The data is compared in a basic quantitative manner, where we assess percentage differences between ex ante and ex post proforma outputs.

We also identify differences that arise in input variables for costs (hard costs and soft costs) and revenues. These three line items, collectively, reflect all inflows and outflows to the developer, and thus all have an impact, albeit varied, on equity unlevered IRR. Differences between these line items are identified in two ways: aggregate difference (magnitude) between the ex ante and ex post proforma; and relative difference in the timing of cashflows (duration, start, and finish). Furthermore, we use qualitative data for each transaction to articulate how differences between the expected and actual input variable values affected the realized returns. Comparative data for each project have been displayed graphically whenever possible.

The following chapter summarizes our findings. Chapter 5 illustrates differences between the ex ante and ex post proformas, and identifies, when relevant, reasons expected IRR differed from realized IRR.

Chapter 5 – Analysis of Ex Ante and Ex Post Development Proformas and Results

5.0 Analysis

PROJECT 1

The project is a 42-unit condominium development located on a waterfront parcel in a tertiary New England city. The development was initially designed to provide efficiency units to a fringe urban market, heavily populated by the working class. The entire development consists of approximately 27,987 sellable square feet, or an average of 666 square feet per dwelling unit. The total development cost of the project (including acquisition, hard costs and soft costs) was approximately $9,612,500 (an average of $228,869/unit), or $343.46/SF of sellable building area. The deal began with the land acquisition in Q1 2005 and concluded with the completion of construction in Q4 2007. Sellout of all condominium units was also completed in Q4 2007.

Equity Unlevered IRR & Deal Summary

Unlevered ex ante equity unlevered IRR was estimated, based on initial cashflow projections, to be 26.8%. However, the ex post equity unlevered IRR was 1.0%. The ex post return was approximately 96.26% lower than the ex ante projected IRR. The shortfall in actual return to the project resulted directly from a decline in realized revenues, and increases in both hard and soft costs. The decline in revenues was primarily the result of a softening in the overall market and unit mispricing. Together, the softening and mispricing resulted in marked change in sales velocity and overall transaction duration.

Housing vacancies in the submarket increased following substantial layoffs by the area's two largest employers, and the marginal second/third home market collapsed with the constriction of the capital markets. Also, a competing project, located just miles away from the site, offered buyers substantial free upgrades and improvements while few incentives were offered to prospective buyers at Project #1. Ineffective print and radio marketing efforts, coupled with prolonged carry costs resulted in the 35.2% increase in soft costs. Hard costs increased dramatically when changes in finish scope were prescribed in an effort to attract attention from wealthy demographic groups to increase sales velocity.

	Ex Ante	Ex Post	% Difference
Revenues	$11,699,250	$9,750,053	-16.7%
Hard Costs	$1,695,750	$2,536,456	49.6%
Soft Costs	$1,677,898	$2,269,080	35.2%
Unlevered IRR	26.8%	1.0%	-96.1%

Table 5.1

Discussion of Major Line Items in Ex Ante and Ex Post Proformas

Revenues

The ex ante projection of net revenues for Project #1 was $11,699,250 (an average of $278,553/unit), while ex post revenues totaled just $9,750,053 (an average of $232,144/unit). This indicates an aggregate over-estimation of net revenues of 16.7%. On a sellable square foot basis, the ex ante proforma projected an average sales price of $418.02 per sellable square foot while ex post pricing was $348.38 per sellable square foot. A graphical presentation of ex ante versus ex post net sales revenues for this development project is provided below:
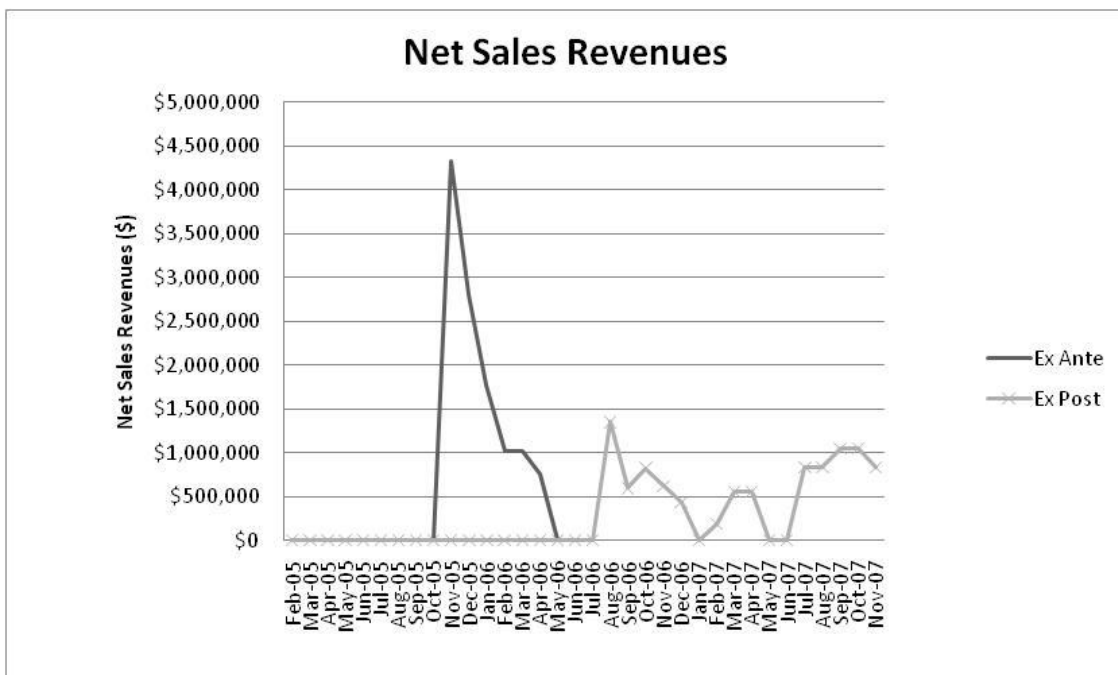
Figure 5.1

In addition to the over-estimation of revenues, the graph above depicts a discrepancy in timing of sales revenues between the ex ante and ex post proforma. Ex ante sellout was estimated to last eight months following completion of construction, however the ex post proforma indicates that sellout actually occurred over 17 months. Perhaps more importantly, where the developer initially predicted that sellout would conclude by May, 2006, condominiums sales at Project #1 did not *commence* until July, 2006. Timing delays resulted in delivery of units to a residential market that was beginning to experience a decline in demand. Both pricing and pace of sales suffered substantially as a result. Changes to marketing materials, sales team, and project branding occurred over the course of construction and sellout, and resulted in buyer confusion and poor project visibility.

Hard Costs

Ex ante projection of hard costs for Project #1 was $1,695,750, while the ex post proforma indicates that actual hard costs equaled approximately $2,536,500. The under-estimation (49.6%) of hard costs and change in timing of hard costs are depicted in the graphic below:
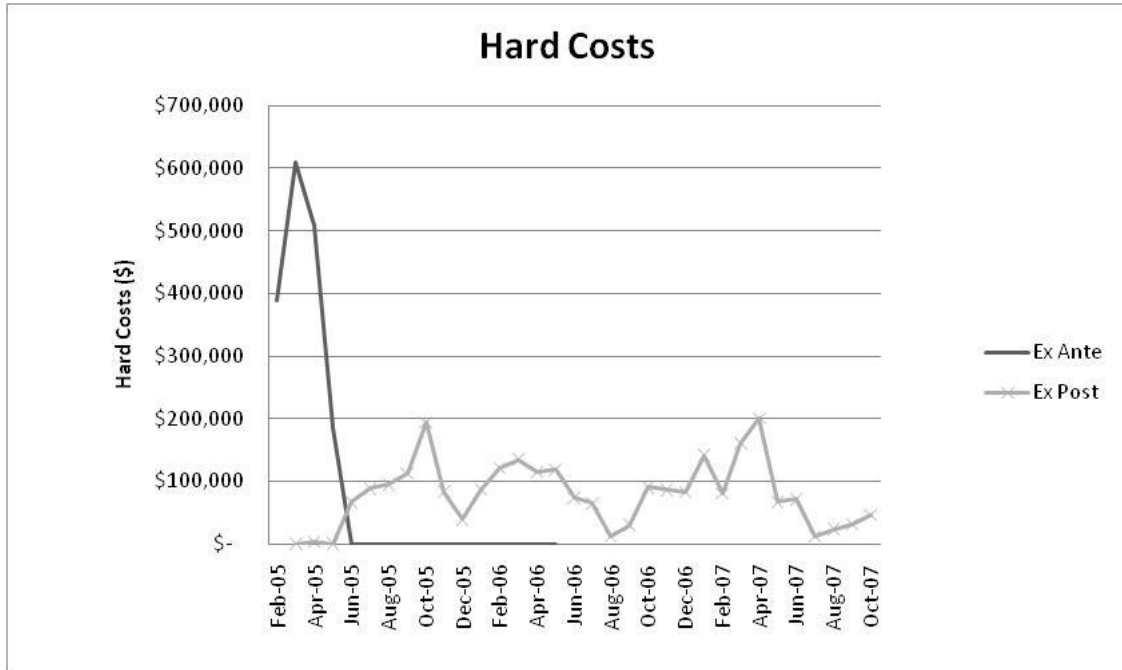
Figure 5.2

The graphic demonstrates changes in total hard costs incurred, and the timing of all hard cost outflows. Cost changes were a direct result of upgrades to finish scope for the units and the common areas. The developer hoped to transition the property to attract wealthy buyers looking for a pied-à-terre. The modifications required a change of general contractor and brokerage company, both resulting in extensions of overall project schedule. Costs were more evenly spread over the project schedule because the change in general contractors from a large production contractor to a small specialized luxury homebuilder resulted in a decline in available construction horsepower. While the ex ante proforma proposed a four month construction period, actual construction period for the project lasted 31 months.

Soft Costs

Table 5.1 indicates the 35.2% under-estimation of soft costs in the ex ante projections. Actual soft costs were buoyed by three unanticipated changes to the project;

- Schedule duration increase, resulting from the developer's decisions to change project vendors

- Added marketing costs associated with repositioning the image and brand of the asset during the sellout process
- Additional unexpected architecture and design fees associated with the partial re-design of the dwelling unit and common area finishes

Timing and periodic soft costs are displayed in the graphic below:
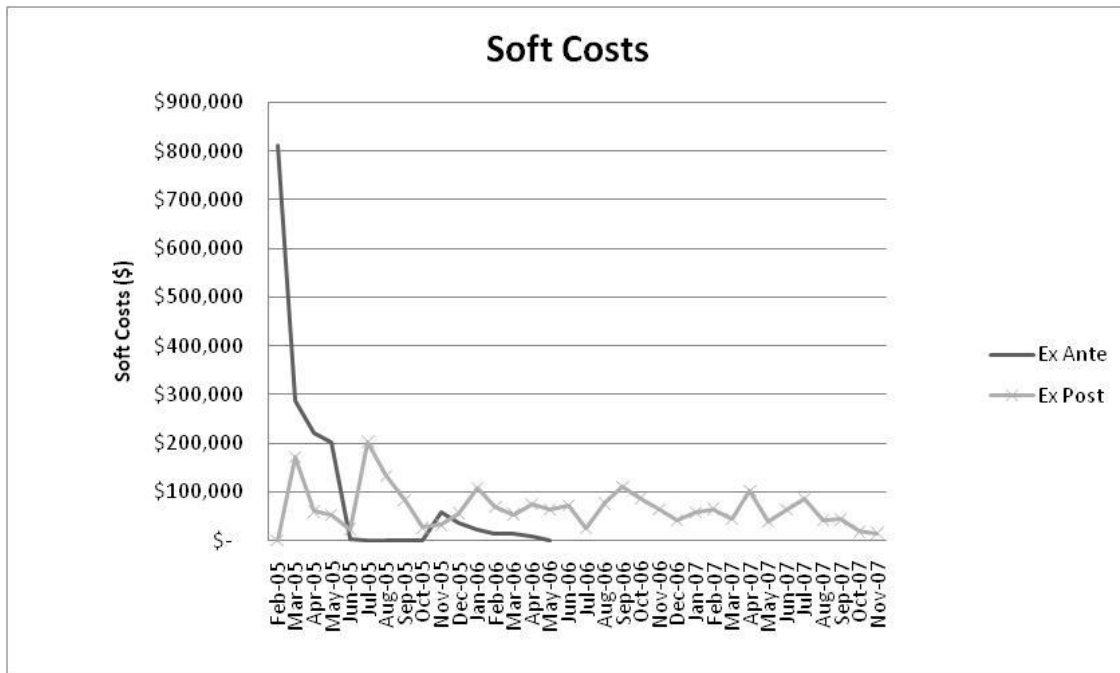
Figure 5.3

We call attention to the original estimate of 15 months of soft costs before sellout is achieved. In reality, project schedule extensions resulted in an increase in overall soft cost schedule to 33 months.

Cumulative Unlevered Cashflows

The graphic below indicates that construction commenced approximately two months later than expected (April 2005). The overall project schedule changes can be directly attributable to developer modifications detailed earlier. It is important to note that all hard and soft cost overruns ultimately resulted from a misinterpretation by the developer of the target market for the project. The error ultimately led to intentional, endorsed changes to the project in order to reposition the asset.

A graph depicting periodic cumulative unlevered cashflows is shown below:
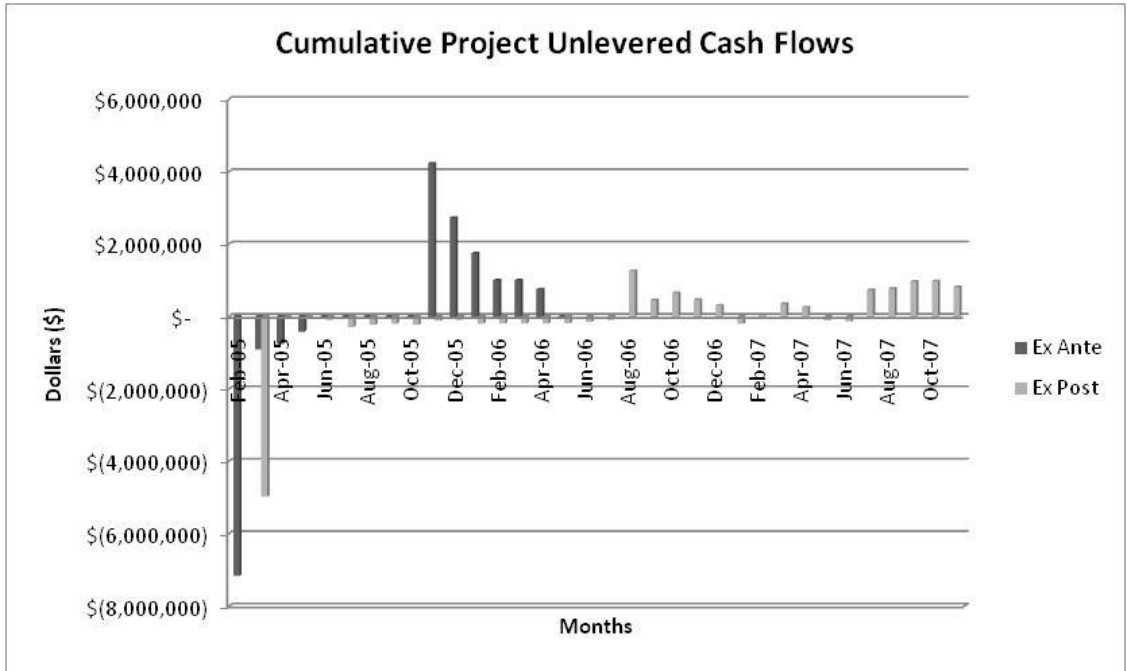
Figure 5.4

Collective changes in expense and revenue magnitude and timing eroded the ex post equity unlevered IRR. The changes, again borne of a rebranding of the asset, were based on developer response to the softening for-sale residential market. It is relevant to consider that while transaction returns were negatively impacted by developer-led project changes, it is conceivable that the situation could have been made worse had changes not been made in response to dynamic supply and demand fundamentals.

We conclude that the unforeseen issues were almost exclusively related to the changing residential market. While many projects experience cost overruns as a result of the mispricing of a static project scope, Project #1 performed more poorly than expected due to demand change and not costing estimation error.

PROJECT 2

This development project is a 22-unit condominium project located in the Central Business District of a secondary New England city. The project consists of approximately 31,800 sellable square feet, or an average of 1,445 square foot per condominium unit. The unit mix includes one-, two-, and three-bedroom homes, built to a luxury level of finish. Total development cost of the project, including all hard costs, soft costs, and land acquisition, was approximately $9,715,000 (an average of $441,590/unit), or approximately $305.50 per square foot of sellable building area. Land was acquired during Q1 2005 and construction was completed during Q2 2006. Sellout of the condominium units was complete in the Q32006.

Equity Unlevered IRR & Deal Summary

Equity unlevered ex ante IRR was estimated at 31.6% based on cashflow projections, while the ex post IRR was 27.3%, approximately 13.4% lower than had been projected. The difference in the two return measures is attributable to the timing of cashflows. In fact, the improvement in aggregate revenues is the result of a developer-led change to project finish specification, which helped offset costs associated with schedule overruns.

As with Project #1, Project #2 was built in a market where demand for production housing was waning, while demand for luxury product remained robust. The modifications made to scope to improve the aesthetics and quality of unit and common area finishes were carefully orchestrated by the developer. Extensive value engineering and program changes were implemented early in the project in order to avoid additional design fees, and to best mitigate increases in material costs. Though hard costs increased a nominal amount ($226,403, or 4.3%), soft cost budgets remained intact because all unit layouts and base building specifications remained the same; modifications were made, exclusively, to finish quality. Added costs associated with finish changes were supported by stronger than expected unit sellout prices (ex ante average sellout was estimated at $348.15 per square foot, while ex post sellout was $374.52 per square foot – an increase of 7.6%).

	Ex Ante	Ex Post	% Difference
Revenues	$11,071,300	$11,909,646	7.6%
Hard Costs	$5,285,539	$5,511,942	4.3%
Soft Costs	$948,187	$902,029	-4.9%
Unlevered IRR	31.6%	27.3%	-13.4%

Table 5.2

Discussion of Major Line Items in Ex Ante and Ex Post Proformas

Revenues

The ex ante projection of net revenues for this development project was $11,071,300 (an average of $503,240/unit), while ex post revenues totaled $11,909,646 (an average of $541,347/unit). This under-estimation of net sales revenues by 7.6% is depicted, on a periodic basis, by the following graphic:
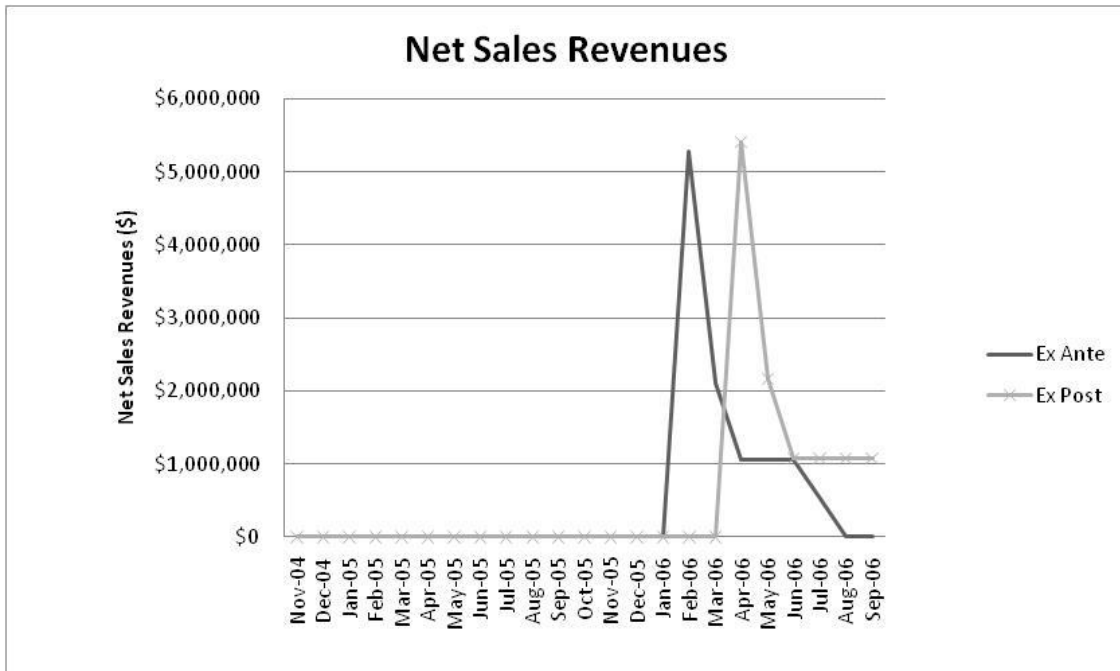
Figure 5.5

In this case, the projection of net revenues was marginally underestimated however the graph demonstrates that the primary difference between the ex ante and ex post proformas was timing of cash inflows. Project #2 ex ante revenues were expected approximately two months before the ex post revenues were received. The change in the transaction schedule occurred at project commencement, when the changes were made to finish specification. Despite minimal additional hard costs and stable soft costs, construction commencement was delayed while design modifications were made. We witness in the above graphic that actual construction duration was consistent with ex ante expectations of duration, however the schedule delay early in the project shifted all transaction expenses and revenues further into the future. Interestingly, after scope changes were made by the developer, realized net sales revenue and forecasted revenue were nearly identical in magnitude and velocity.

Hard Costs

Timing and magnitude of expected and realized hard costs are illustrated in the graphic below:
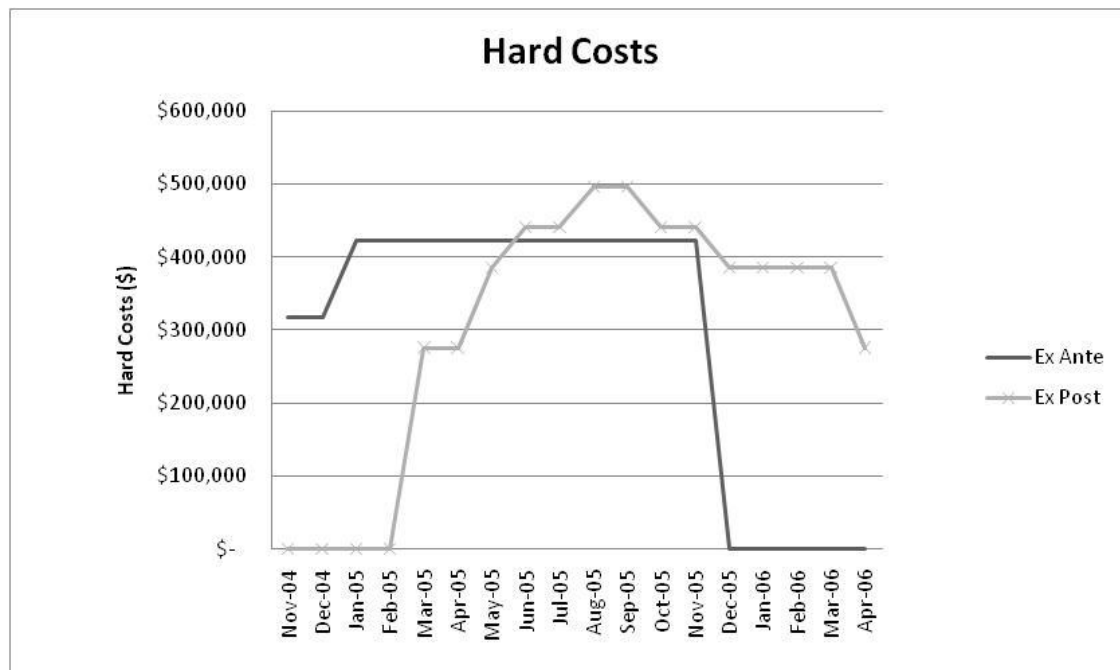
Figure 5.6

While ex ante and ex post net sales revenue projections closely mirror one another, volatility of actual hard costs was substantially different from the ex ante projected hard costs. Aggregate hard costs between the proformas were similar ($5,285,539 – ex ante to $5,511,942 – ex post) however we make the following two observations of the above graphic:

- The developer elected to straight-line ex ante projected hard costs, despite the fact that project costs would seldom follow such a stable schedule;
- Ex post hard costs exhibit limited volatility, particularly during the later stages of construction

It appears the developer expected and realized stable cash outflows for hard costs. The lack of volatility is particularly surprising given the nature of the vertical construction process and cost patterns. One would expect that when the large project trades, like steel and drywall/framing, are released to secure materials or to commence activity onsite that hard costs would increase sharply. During Project #2, however, the developer was particularly careful to monitor and govern material purchases and labor billing. We glean from the developer interview that this was done intentionally to ensure that any budget issues that occurred later during construction could perhaps be better accommodated in the original construction loan if care was taken to maintain a large undrawn balance on the loan for as long as possible.

Soft Costs

The following graphic illustrates Project #2 periodic soft costs:
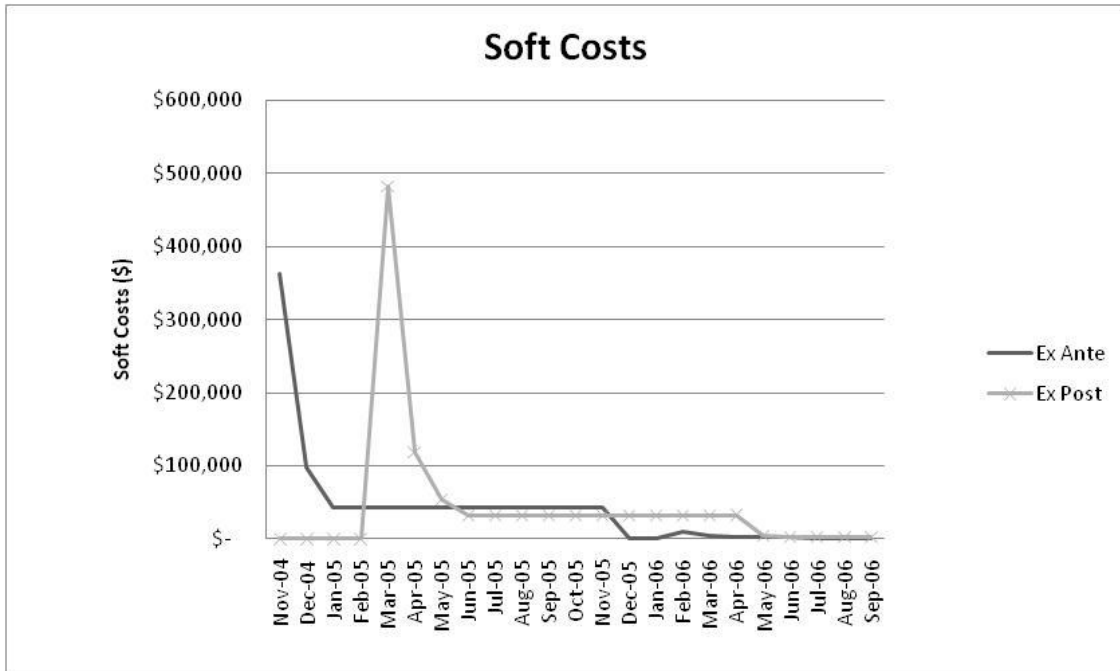
Figure 5.7

Ex ante and ex post soft costs reflect the project delay articulated in earlier sections of the project assessment. One observation of the ex post costs is the stagnation of costs after May, 2005. It appears that after a substantial initial investment in marketing materials, graphics, and marketing suite, costs remain relatively stable. The recurring cost thereafter was related to periodic advertising fees and broker gifts. The large spike in soft costs in March 2005 far exceeds the ex ante projected spike in November 2004, as ex ante marketing efforts were not expected to include the construction and decoration of a marketing suite. The developer of Project #2 believes the additional investment in soft costs, as it relates to marketing and advertising, was substantially responsible for the increase in realized net sales revenues.

Cumulative Unlevered Cashflows

The ex ante projection of construction duration for the project was 13 months, with an expected total project duration of approximately 21 months. Construction began approximately four months later than anticipated, and lasted 14 months, or one month longer than originally projected. What is interesting is that the ex post total development period lasted just 19 months, 2 months less than estimated in the ex ante proforma. A graph depicting the periodic cumulative unlevered cashflows follows:
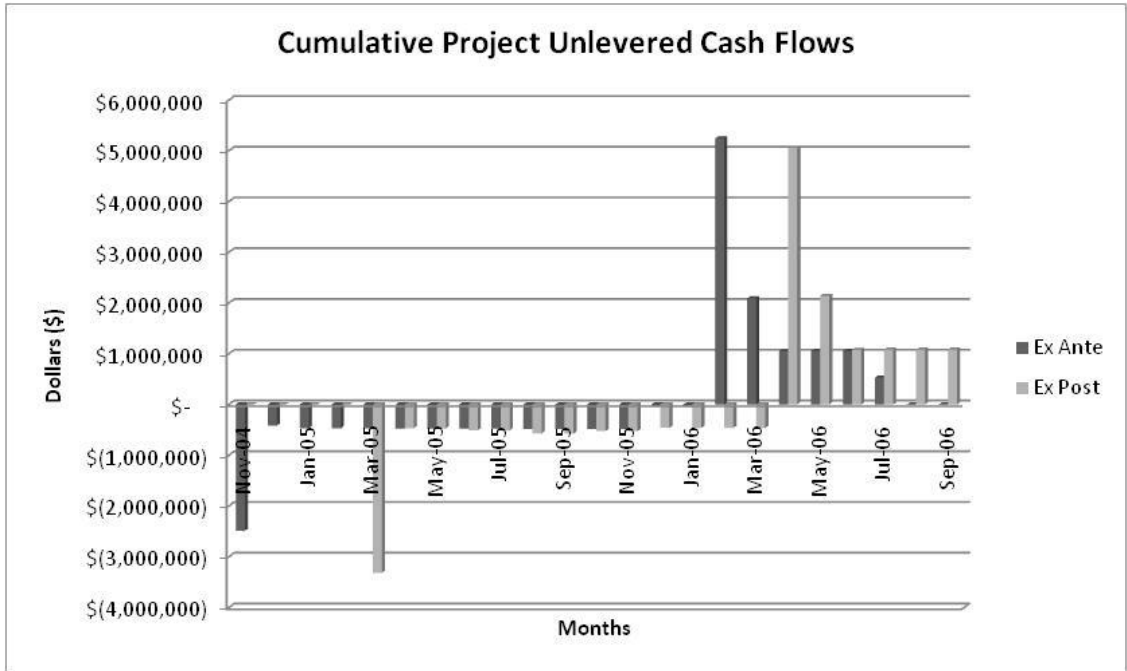
Figure 5.8

The development team is insistent that focus on the marketing initiative shortened the overall transaction period. Had the development transaction lasted 21 months, as predicted in the ex ante proforma, the development team anticipates that additional soft costs would have totaled in excess of $100,000, excluding accrued construction loan interest. A qualitative note, the developer believes that market demand for luxury units had also begun to soften during Q3 2006, and that the acceleration of project sellout was increasingly important.

We can conclude that the developer's intuition to modify construction scope and to bolster marketing initiatives was an ideal response to then-current market conditions, and helped preserve the equity unlevered development IRR.

PROJECT 3

This development project is a 10-unit condominium project located in an urban area of a primary New England city. The project location offers immediate access to transit lines, including subway and bus lines, as well as major thoroughfares running east to west, and north to south. The development consists of 16,004 sellable square feet, or an average of 1,600 sellable square feet per condominium unit. The total development cost of the project, including acquisition, hard costs and soft costs, was approximately $7,275,000 (an average of $727,500/unit), or approximately $454.57 per square foot of sellable building area. The deal commenced when the developer obtained site control in Q2 2006, and construction and sellout were both completed Q2 2009.

Equity Unlevered IRR & Deal Summary

Equity unlevered ex ante IRR was 31.01%, and ex post IRR was 16.30%. The 47.4% decline in actual IRR was attributable to schedule overruns, which resulted from a delay in construction. The delay was caused primarily by an under-estimation of the time required to achieve permits. Because the project was constructed in an area where extensive community process is typical, the time required to appease permitting agencies and surrounding residents exceeded initial expectations. Additional soft costs were incurred when the developer was required by the municipality to provide multiple iterations of schematic and conceptual drawings for the community review process.

Hard costs also exceeded ex ante expectations because the developer was required to alter building elevation and façade finishes, per community review, to better blend with the architectural context of the surrounding urban area. Modifications were also made by the developer to unit finish specifications and base building infrastructure in an effort to target a different condominium buyer demographic. Despite the additional costs, increased development costs were partially offset by an ex post increase in net sales revenues. Most interesting is the error in estimation of the timing of cashflows. We will examine the timing of the cashflows in subsequent sections of the project assessment. The following table summarized project cashflows and returns:

	Ex Ante	Ex Post	% Difference
Revenues	$8,172,396	$8,741,346	7.0%
Hard Costs	$3,320,424	$4,384,070	32.0%
Soft Costs	$624,267	$854,308	36.8%
Unlevered IRR	31.0%	16.3%	-47.4%

Table 5.3

Discussion of Major Line Items in Ex Ante and Ex Post Proformas

Revenues

Ex ante projection of net sales revenues for the transaction was $8,172,396 (an average of $817,240/unit), while ex post net sales revenues totaled approximately $8,741,346 (an average of $874,135/unit). This under-estimation of net sales revenues of 7.0% is depicted below:
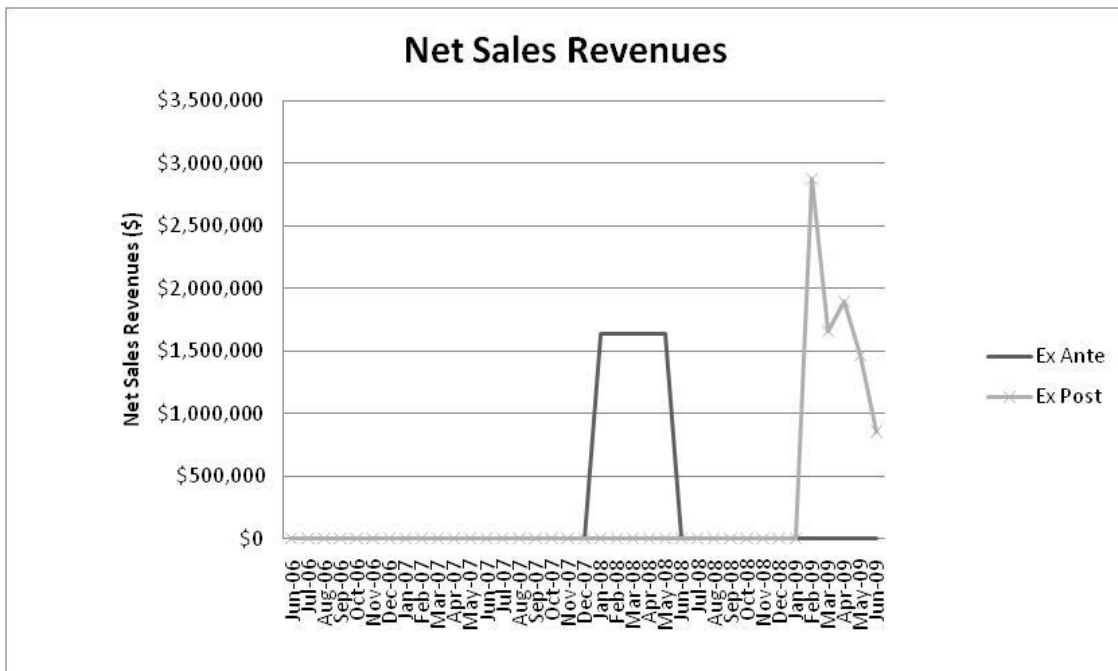
Figure 5.9

Three key points are illustrated by the graphic:

- Sellout commencement and completion occurred approximately eight months after initially forecast in the ex ante proforma;
- Overall time to sellout was consistent between the ex ante and ex post proformas (five months);
- Sellout pace was underestimated in the ex ante proforma, as more units than expected were sold during the initial three months following completion of construction

Ex ante sales were expected to begin in January 2008, with sellout concluding by May 2008. The ex post proforma, however, indicates that sellout did not commence until February 2009, with completion in June 2009. The delay in sales resulted from both a construction commencement delay of approximately four months, and a longer-than-expected construction period. Based on conversation with the developer, the spike in first month sales resulted from pent up demand, based on an increased number of unit

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reservations signed during the late stages of construction, and improved buyer response to the changes made to unit finish level.

Hard Costs

Ex ante and ex post transaction hard costs are illustrated below:
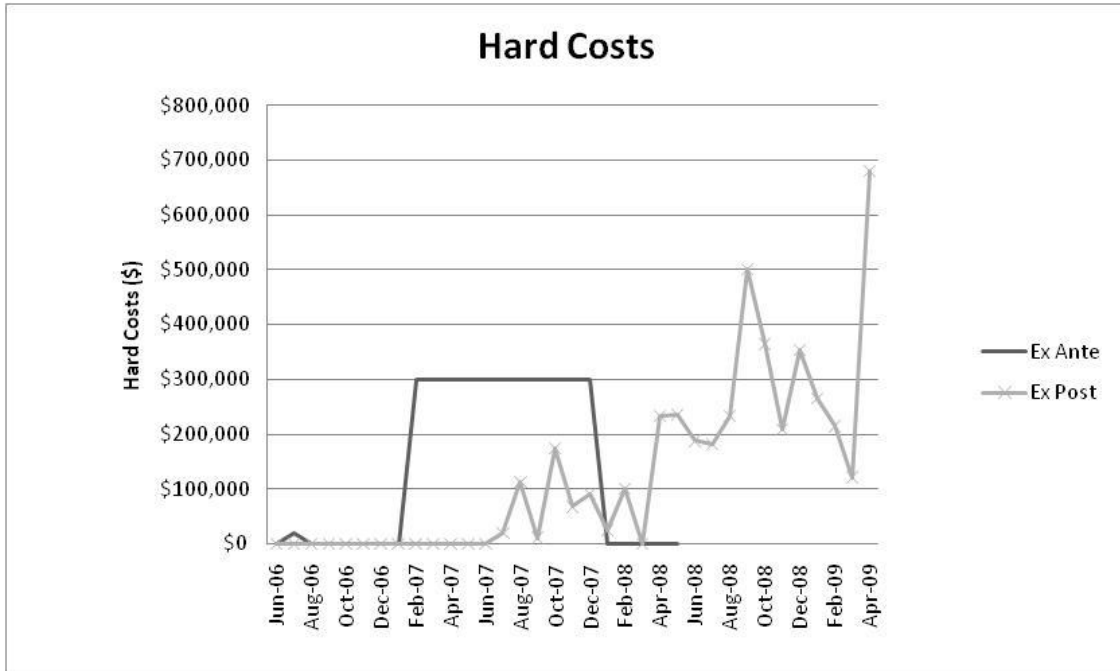
Figure 5.10

The graphic illustrates that the developer projected ex ante hard costs to occur in equal increments from February 2007 through December 2007. Ex post hard costs differ in both timing and volatility. Commencement was delayed by the prolonged community process, and duration exceeded expectations in part because much of the construction was pushed into the winter months of calendar year 2007.

The building envelope had not been completed at the time winter weather became prohibitive, and resultantly, much of the interior framing, drywall, and finish work could not begin until the structure was water-tight in Q1-Q2 2008. Also, construction duration exceeded ex ante projections due to substantial changes made to unit finishes. The original design targeted middle-income buyers however modifications to unit layouts, appliance packages, and flooring specifications resulted in the marked increase in the overall hard cost budget ($1,063,646). All unit changes were programmed by the developer in order to target high-income buyers that were believed to be less sensitive to the volatile housing market conditions.

The developer estimated hard costs to be incurred over an 11 month period. Actual hard costs were incurred over a 22 month period (June 2007 through April 2009).

Soft Costs

A graph below illustrates transaction ex ante and ex post soft costs:
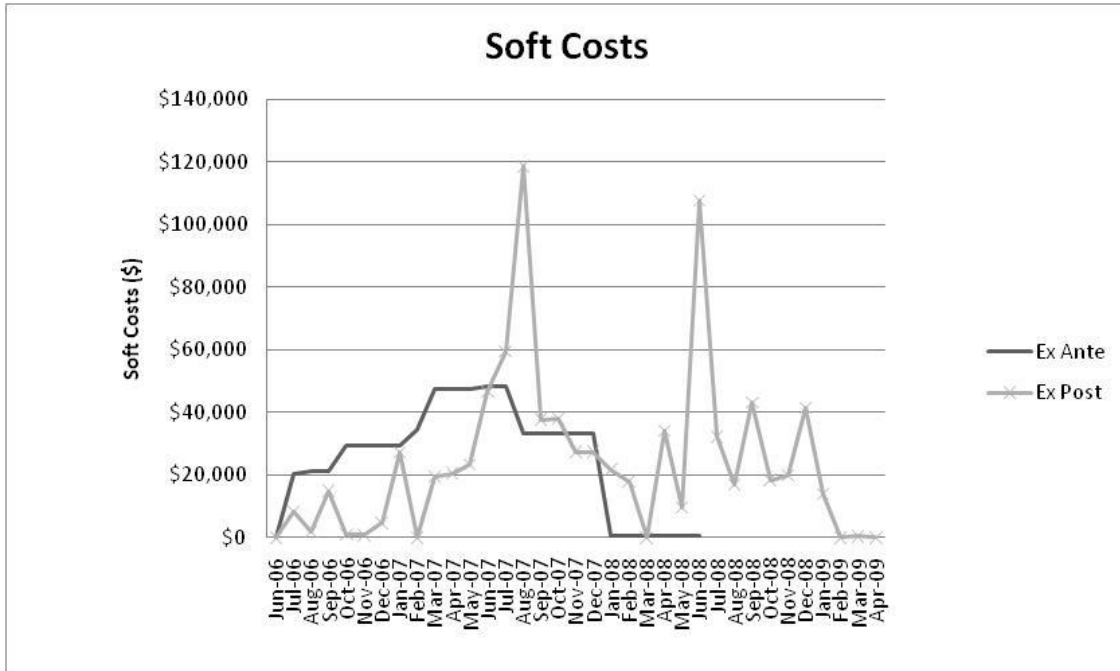
Figure 5.11

The aggregate under-estimation of soft costs (31.7%) resulted from three changes to development:

- Initial soft costs exceeded ex ante expectations because more detailed conceptual and schematic drawings were requested by concerned neighbors and permitting agencies during the entitlement process;
- Redesign fees were incurred when the developer modified unit layouts and finishes, requiring revised architectural and mechanical drawings;
- Preliminary marketing materials were reproduced to with revisions to incorporate all developer changes to the project

The dramatic increase in soft costs incurred during Q2-Q3 2007 correspond to the permitting design drawings, and the second spike in soft costs corresponds to all costs associated with the project scope revisions.

The ex ante proforma indicated project soft costs would be incurred over a 23 month period, however ex post realized soft costs were incurred over 31 months, curtailing five months before completion of condominium unit sales.

Cumulative Unlevered Cashflows

Developer ex post proforma indicates that construction did not begin until June 2007 (4 months later than expected) and was completed in April 2009, resulting in a 23 month construction period. Ex post total development period was 36 months, which exceeds the ex ante project by 12 months. A graph depicting cumulative periodic unlevered cashflow timing is shown below:
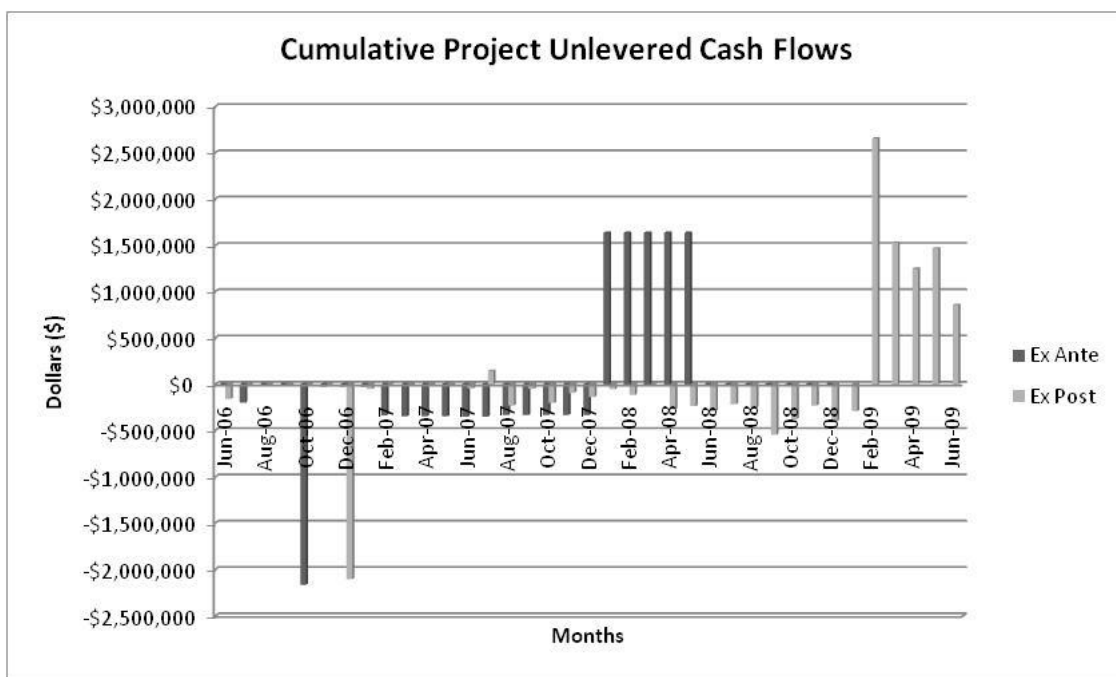
Figure 5.12

Overall project schedule was impacted by permitting duration, and changes to scope. Despite the volatility of hard costs and soft costs incurred, per the ex post proforma, the graph of cumulative project costs indicates that the periodic magnitude of all costs incurred was similar to ex ante projections. Project changes resulted in overall cost increases, as well as an increase in total net sales revenue, however equity unlevered returns were nearly halved.

The developer commented that it was fortunate to offset additional costs associated with project delays with realized revenues that exceeded ex ante projections. Furthermore, considering the softening demand for condominiums at the time of delivery (February 2009), the development team expressed sincere satisfaction with the ex post development transaction return of 16.30%.

PROJECT 4

This development project is a 72-unit condominium project located in the Central Business District of a tertiary New England city, adjacent to a major mass transit station. The development consists of approximately 60,204 sellable square feet, or an average of 836 square foot per condominium unit. The total development cost, including hard costs, soft costs, and land acquisition, was approximately $13,362,000 (an average of $208,781/unit), or approximately $221.95 per sellable square foot. Land acquisition occurred in Q4 2005, and construction was completed during the Q3 2007. Total sellout was completed during Q4 2007.

Equity Unlevered IRR & Deal Summary

Equity unlevered ex ante IRR was 34.7%, while the ex post equity unlevered IRR was -17.4%. The decline in transaction IRR (150.1%) lower than the ex ante projected IRR. A loss of equity capital occurred, according to the developer, as a direct result of poor market timing, and misinterpretation of target market demand.

The delivery of 72 units to the area at a tenuous time in the overall condominium market resulted in a significant reduction in average sellout pricing. Ultimately, pricing was governed by the construction lender in order to maintain sellout momentum and aggregate sellout value in an effort to recover the value of the construction loan. The developer was retained at a reduced administration fee to facilitate project completion and sales.

Despite the lender's best efforts, overall net sales revenues fell short of total development costs by approximately $1,573,056. The collapse of the credit market directly affected the targeted demographic, which was heavily reliant on subprime financing to purchase the condominium units. The tertiary location, home to many blue-collar and low-income workers, was particularly affected by the financial crisis, which resulted in substantial increases in unemployment levels and property foreclosures. Increases in hard costs and soft costs resulted from lender-approved unit upgrades and buyer incentives used to accelerate the pace of sellout.

	Ex Ante	Ex Post	% Difference
Revenues	$14,964,763	$11,788,944	-21.2%
Hard Costs	$8,662,276	$10,070,064	16.3%
Soft Costs	$1,269,549	$1,621,168	27.7%
Unlevered IRR	34.7%	-17.4%	-150.1%

Table 5.4

Discussion of Major Line Items in Ex Ante and Ex Post Proformas

Revenues

Ex ante net sales revenues for Project #4 were estimated at $14,965,000 (an average of $207,844/unit), while actual net sales revenues equaled $11,788,944 (an average of $163,735/unit). Both ex ante and ex post net sales revenues are illustrated below:
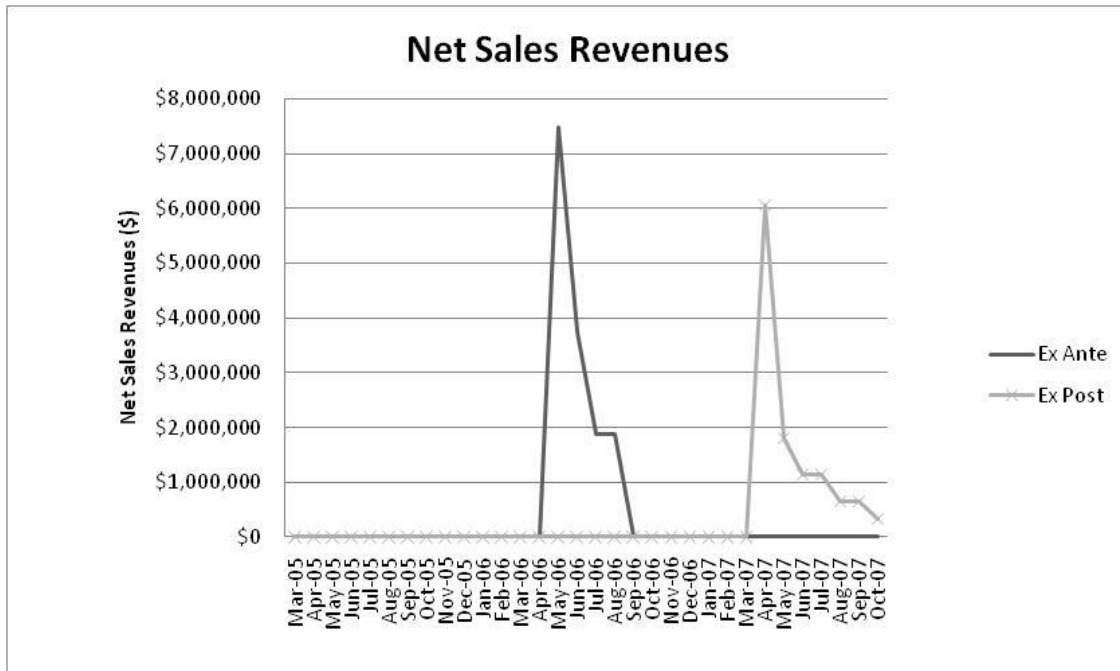
Figure 5.13

Average ex ante sellout price per square foot was $248.57, and average ex post price per square foot was $195.82. The over estimation of net sales revenues can be directly attributed to lender involvement in the marketing and sales process. Buyer incentives, including reduced condominium fees, pre-paid real estate taxes, unit upgrades, parking credits, and retail store gift cards (for furnishings) were used to entice reluctant prospective buyers. Sales prices were dramatically reduced to afford the construction lender an opportunity to recover original capital quickly, and to avoid further weakening of market demand.

Considering the increase in foreclosures in the tertiary location, the lender anticipated that additional delays to overall sellout would result in increased competition from foreclosure inventory. Moreover, with inventories swelling in neighboring towns, it became increasingly difficult to attract buyers from outside the immediate area. Fighting the submarket stigma and economic recession required quick action. The developer's loss of control and fee revenue resulted in tension between the parties, which is believed to have caused further overall schedule delays.

Hard Costs

The chart below illustrates both ex ante and ex post transaction hard costs:
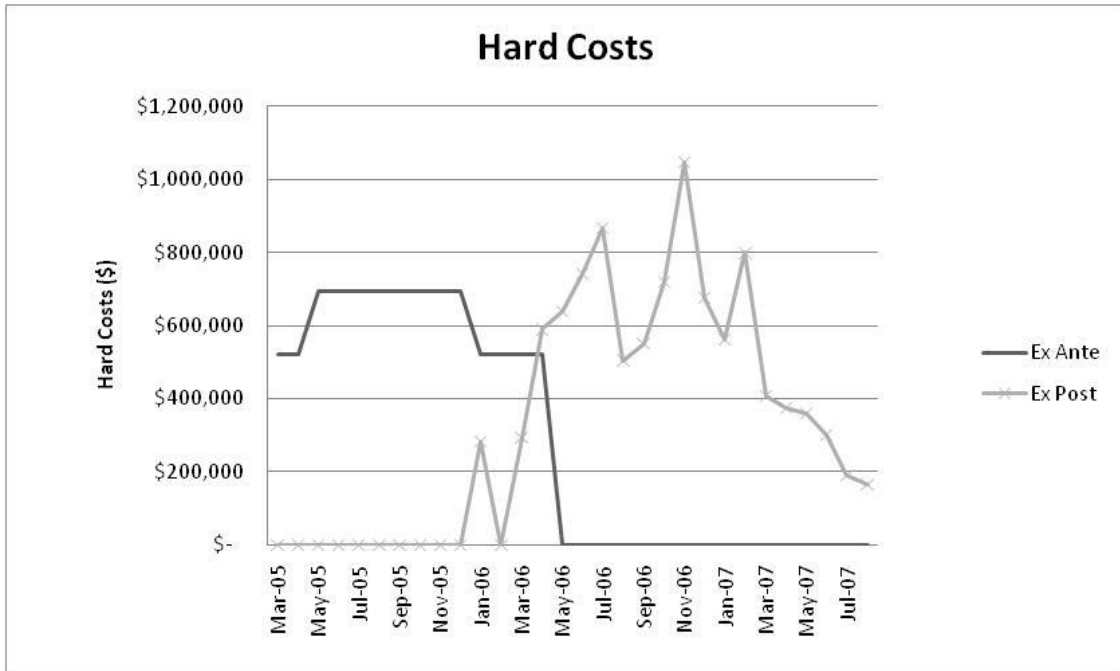
Figure 5.14

Ex ante projection of hard costs for this development project totaled $8,662,000 (an average of $120,309.39/unit), while ex post actual hard costs incurred equaled $10,070,064 (an average of $139,862). The under-estimation of hard costs by the developer was the result of the following unforeseen issues:

- Soil and demolished building material remediation;
- Site utility infrastructure capacity and construction deficiencies (gas and electric);
- Building envelope failure causing extensive water damage;
- Sprinkler system rupture causing additional water damage (repair costs were partially recouped via a claim against insurance);
- State construction code violation of rating requirements for duct chases and elevator shafts

The developer was fortunate to mitigate some unanticipated hard cost overruns due to strong relationships with the general contractor and architect. Drawing revisions and construction repairs were made quickly and efficiently in order to accelerate overall project schedule whenever possible, however project duration grew to 20 months from the ex ante projection of 14 months because of interim repairs required for water-

damaged framing and drywall. Overall hard cost timing was delayed when subcontractors detected toxic materials in footprint soils and demolished material. Aside from the added expense associated with selective remediation and exportation, considerable time was spent determining the extent of toxicity and the volume of affected material.

Soft Costs

The following graphic details ex ante and ex post development transaction soft costs:
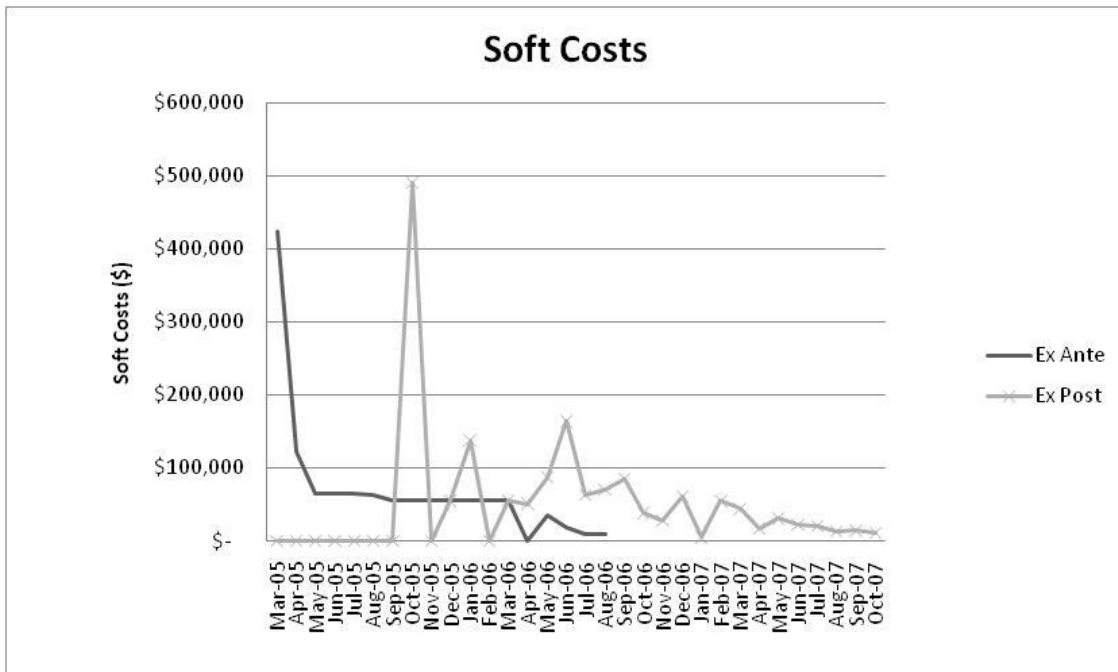
Figure 5.15

The ex ante projection of soft costs for the development project totaled $1,269,550 (an average of $17,632.62/unit), while ex post actual soft costs totaled $1,621,000 (an average of $22,516.22/unit). The 27.7% under-estimation of soft costs resulted, predominantly, from additional unexpected marketing fees and administrative costs related to the prolonged project duration. Marginal added costs for architectural sketch details and revised drawings were incurred during Q2 2006, and again during Q1 2007. Code violations and the resubmission of construction drawings to the municipality resulted in significant re-inspection and municipal fees.

Attorney involvement in the pursuit of both the natural gas and electric utility companies during Q3 2006 was an additional unanticipated soft cost. Existing infrastructure was obsolete and undersized, requiring substantial subsurface construction, which also negatively impacted overall project schedule.

Cumulative Unlevered Cashflows

The developer originally anticipated an overall project duration of 18 months, of which 4 months were predicted for project total sellout, with development completion in Q3 2006. Instead, the total project duration was approximately 25 months, with 7 months required for sellout of all condominiums.

A graph of cumulative unlevered cashflows follows:
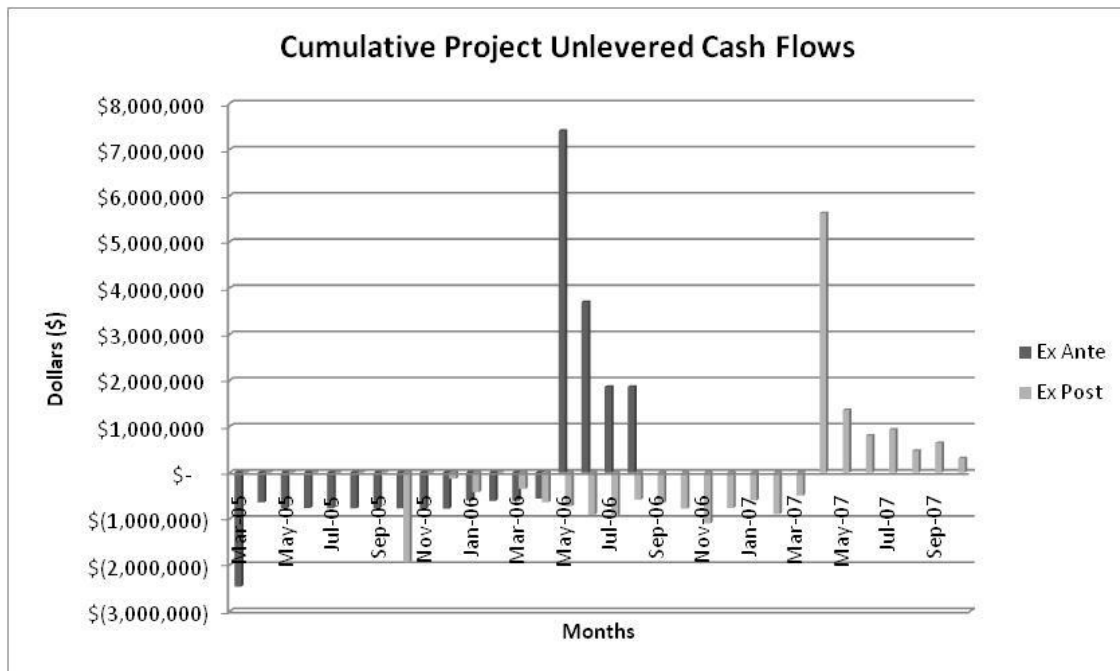
Figure 5.16

Development transaction commencement was delayed during the entitlement process, hampering the pre-development, construction, and selling phases of the project. The acquisition of all required parcels was delayed from Q1 2005 to Q4 2005, resulting in slowed early construction due to inclement winter weather. Once construction was underway, schedule was further impacted when cold, damp weather affected both site subsurface conditions – the level of the water table beneath the basement slab rose substantially – and building envelope integrity.

The development team and construction lender battled the construction schedule and economic conditions, and ultimately delivered units to the market approximately eight months after the projected development completion date. Anecdotally, the developer contends that, had units been delivered at the ex ante predicted construction completion date, actual sellout pace and pricing would have more closely resembled ex ante forecasts.

PROJECT 5

This development is a 21-unit residential condominium project located in a historic neighborhood of a primary east cost urban area. The project is three-story stick frame construction partially spanning at-grade parking, and units are separated into two buildings. A surface parking area serving area residents and neighbors surrounds the site. The entire development consists of approximately 19,582 sellable square feet, or an average of 932 square feet per dwelling unit. Total development costs were approximately $6,773,064 (an average of $322,527/unit), or $345.88 per sellable square foot. The deal commenced with the acquisition of a primary parcel – approximately 85.0% of the aggregate footprint – in April 2004 (an adjoining subsequent parcel was purchased in August 2005). After an extensive entitlement process, construction began Q1 2006 and was completed in Q1 2007, lasting approximately 13 months. Sellout of the condominium units was also completed Q1 2007, 35 months after initial land acquisition.

Equity Unlevered IRR & Deal Summary

Equity unlevered ex ante IRR was estimated to be 15.8%, while the ex post equity unlevered IRR was actually -1.6%. The ex post return, approximately 110.0% lower than the ex ante projected IRR. Overall project schedule was negatively impacted due to a prolonged entitlement process. Project #5, like Project #3, was permitted in an urban area where neighborhood groups and municipal entities were particularly cognizant of new development, and its impact on existing infrastructure and housing inventory.

Correspondingly, the community process involved many iterations of drawing review in order to incorporate neighborhood feedback into the overall project design. The developer indicated that the original project proposal included two four-story buildings, housing a total of 36 condominium units. Community groups opposed the project because of its perceived impact to the area, and were instrumental in the reduction of total units from 36 to 21. Aside from scope changes that increased project hard costs and soft costs, the extended permitting process added substantially to the overall schedule, pushing the receipt of net sales revenue into the future. The increase in time to positive cumulative cashflow is to blame for the negative ex post equity unlevered IRR.

	Ex Ante	Ex Post	% Difference
Revenues	$6,874,072	$7,352,304	7.0%
Hard Costs	$3,320,783	$3,839,000	15.6%
Soft Costs	$902,367	$1,144,714	26.9%
Unlevered IRR	15.8%	-1.6%	-110.0%

Table 5.5

Discussion of Major Line Items in Ex Ante and Ex Post Proformas

Revenues

The ex ante projection of net revenues for Project #5 was approximately $6,874,072 (an average of $327,337/unit) or $351.04 per sellable square foot, while ex post actual net sales revenues totaled approximately $7,352,304 (an average of $350,110/unit) or $375.46 per sellable square foot. Revenue timing and the aggregate under-estimation of 7.0% are evident in the graph below:
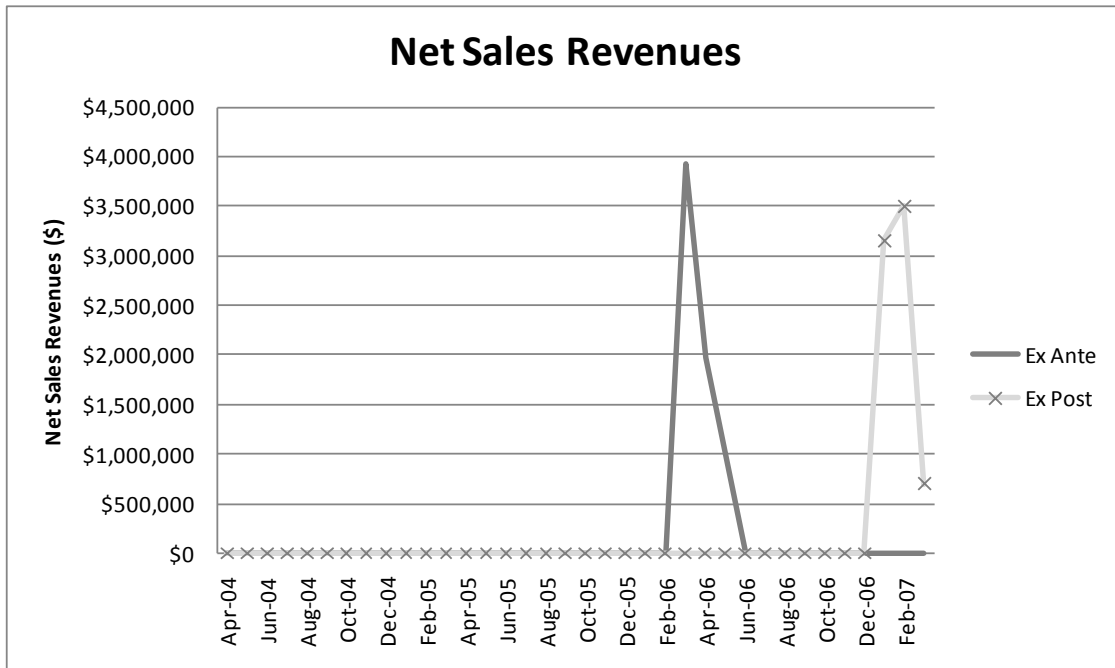
Figure 5.17

While there is a discrepancy in aggregate value of net sales between the ex ante and ex post development proforma, the more significant underlying difference was in the timing of cash inflows. The ex post proforma indicates that revenues were realized approximately 10 months after originally expected. The discrepancy in timing is born of an entitlement period that lasted nearly 9 months longer than was estimated in the ex ante proforma.

The delay to receipt of net sales revenues is also a result of an increase in construction time period. Modifications were made to the building interior and exterior to better conform to the desires of neighborhood groups and the governing municipality. Changes made prior to and during construction resulted in delays to accommodate revised material bidding and procurement.

Pace and volatility of condominium sellout was consistent between the ex ante and ex post proformas, perhaps suggesting that, despite project schedule overrun, the developer had appropriately estimated market demand and sales velocity.

Hard Costs

A graph of ex ante and ex post development hard costs follows:
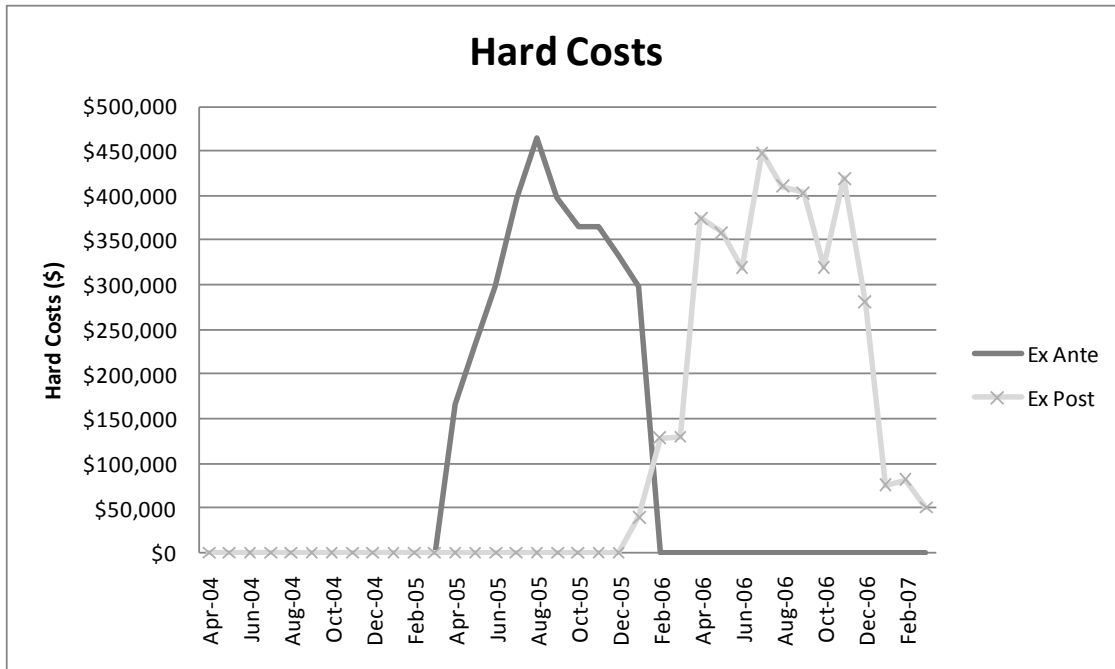
Figure 5.18

The ex ante projection of hard costs for the development project was $3,320,783 (an average of $158,133/unit), while ex post proforma hard costs totaled approximately $3,839,000 (an average of $182,810/unit). The under-estimation of hard costs (15.6%) resulted from scope modifications and finish specification changes. Façade elements and rooftop design and aesthetic were of particular concern to area residents, resulting in the use of costly construction materials and specialty subcontractors. Landscape changes were also implemented to soften the transition at grade from structure to the surrounding sidewalks.

We observe a general pattern of diminished hard costs as the development transaction nears physical completion. It is evident, however, that two dramatic discrepancies exist between the ex ante and ex post trend lines: the timing of construction commencement and completion were dramatically underestimated in the ex ante proforma; and the overall duration of construction was inaccurately estimated. The ex ante proforma illustrates construction draws spanning 10 months, beginning in April 2005, and concluding Q1

2006. In reality, as demonstrated in the ex post proforma, construction draws spanned 15 months, from January 2006 through March 2007.

Soft Costs

The ex ante projection of soft costs for the development project was $902,367 (an average of $42,969.86/unit), while the ex post proforma details total soft cost expenditures of approximately $1,144,714 (an average of $54,510/unit). This indicates an aggregate under-estimation of soft costs in the ex ante proforma of 26.9% when compared to ex post actual soft costs incurred. We noted that the per-unit soft costs for Project #5 far exceed those of all other residential condominium project analyzed.

The following chart depicts ex ante and ex post soft costs for Project #5:
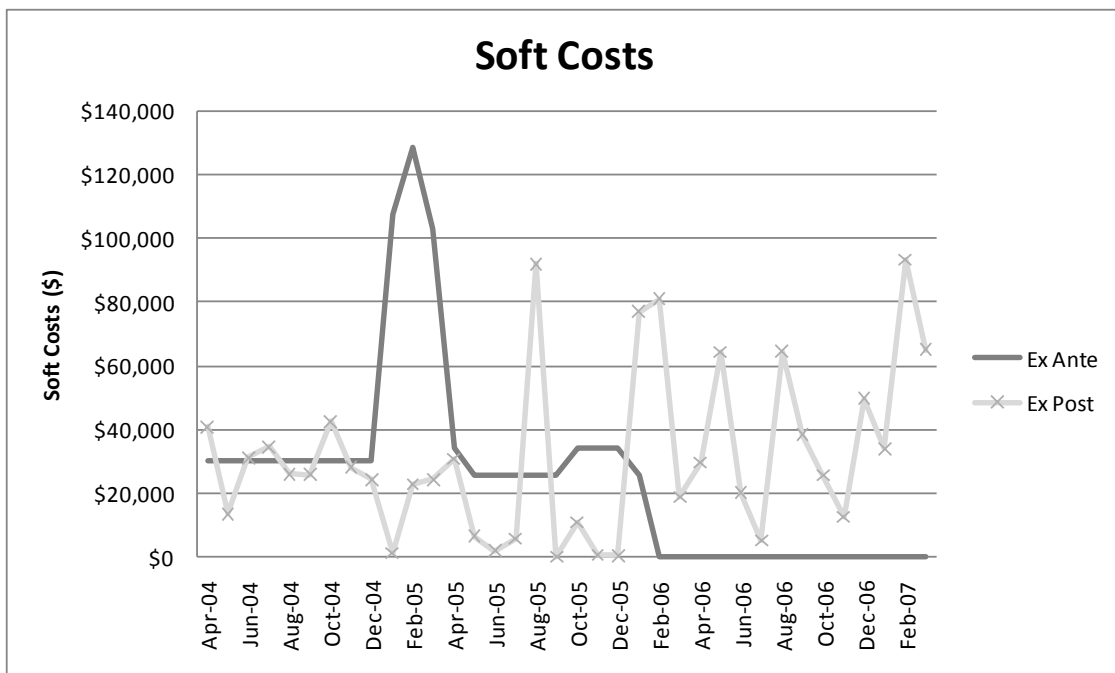
Figure 5.19

The substantial underestimation of soft costs is caused in part by the extended overall duration of the development transaction. Also, added soft costs were incurred during the extended permitting process, where additional architectural and legal costs were incurred in excess of what had originally been forecast. Despite project timing, in regard to then-current economic conditions, the developer was able to maintain the original marketing and sales proforma budget. While increases in this particular component of the aggregate soft cost budget was a concern in other projects, the developer credits a competent marketing team for monitoring costs, and correctly assessing market demand.

As illustrated, it is also evident that actual soft costs incurred were more volatile than had been forecast. Original estimates suggest that most soft costs would be incurred during the design and permitting phases of the development, although actual soft costs during the construction phase far exceeded expectations.

Cumulative Cashflows

As discussed, there exists a vast discrepancy between ex ante and ex post equity unlevered IRR. Anecdotally, despite the improvement in realized revenues versus projected revenues, the added soft costs, hard costs and financing costs incurred during schedule delays caused a pronounced decline in unlevered returns.
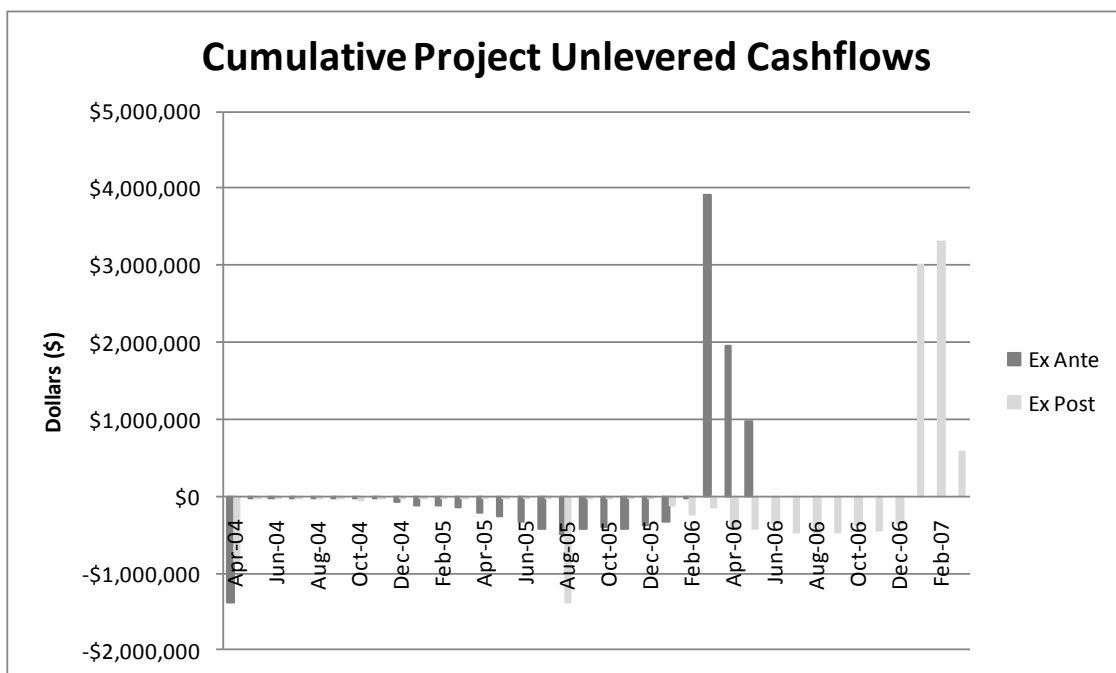
Figure 5.20

Realized cumulative project unlevered cashflows were similar to ex ante cashflow projections, although timing of cash inflows and outflows were inaccurately forecast. Developer feedback indicates, however, that although the community process yielded a substantially different built project, improvements to finish specifications was helpful to both average sellout prices per square foot, and velocity of sales.

Also, the developer was fortunate to have the opportunity to purchase the land in two distinct transactions. Ex ante projections indicate that the land acquisition was expected to occur entirely in Q2 2004, however, as shown in the above graphic, the second development parcel was not purchased until Q3 2005. Delays in the entitlement process enabled the developer to renegotiate the purchase option on the parcel in order

to avoid substantial capital outlay before permits were achieved. Despite efforts to delay land costs, and additional net sales revenues, overall project equity unlevered returns fell far short of expectations.

PROJECT 6

This development project is a 189-key, limited service mid-scale hotel located in an urban area in a primary New England city. The structure is eight stories, constructed of steel and concrete, with all hotel infrastructure, back-of-house, and amenities located on the first two floors of the building. The hotel offers guests access to a restaurant for breakfast, meeting space, business services, and to a small sundry shop. The hotel, totaling approximately 96,700 SF, also offers guests approximately 150 parking spaces, an additional 57,000 square feet, located below grade. Constructed for approximately $144,361 per key, approximately $108,950/key of total development costs was attributed to hard costs, $22,721/key to soft costs, and the balance to financing costs and land lease prepayment. Construction began during the third quarter of 2000, and was completed in approximately 16 months, with delivery occurring during fourth quarter 2001. The project was underwritten using a STR Report, which assessed the competitive set for the hotel, detailing historical average daily rate (ADR), revenue per available room (RevPAR), and revenue per occupied room (RevPOR).

Equity Unlevered IRR & Deal Summary

	Ex Ante	Ex Post	% Difference
Year 1 NOI	$3,448,922	$3,218,456	-6.7%
Stabilized Year NOI	$4,614,410	$4,378,971	-5.1%
Capitalized Stable Year NOI	$43,067,827	$41,287,439	-4.1%
Unlevered IRR	16.0%	18.4%	15.1%

Table 5.6

The ex ante development proforma is shown below:

	DEVELOPMENT		OPERATIONS					Stabilization
	Construction/Development							
	May-99	Oct-00	Oct-01	Oct-02	Oct-03	Oct-04	Oct-05	Oct-06
UNLEVERED ANALYSIS	8.0	10.0	2001	2002	2003	2004	2005	2006
DEVELOPMENT COSTS	(7,312,308)	(24,026,155)						
TOTAL CAPITAL COSTS			(797,354)	(1,575,000)	0	0	0	0
CASH AVAILABLE FROM HOTEL OPERATIONS			3,448,922	3,775,499	4,040,178	4,345,744	4,478,037	4,614,410
MISCELLANEOUS FEES & PAYMENTS			0	0	0	0	0	0
CAPITALIZATION RATE	10.5%							
SALES EXPENSE	2.0%							
TOTAL PROJECT CASHFLOWS	(7,312,308)	(24,026,155)	3,448,922	3,775,499	4,040,178	4,345,744	4,478,037	4,614,410
NET REVERSION PROCEEDS								43,067,827
UNLEVERED CASH FLOW	(7,312,308)	(24,026,155)	3,448,922	3,775,499	4,040,178	4,345,744	4,478,037	47,682,237
UNLEVERED IRR	15.97%	Cash on Cash	11.01%	12.05%	12.89%	13.87%	14.29%	14.72%
UNLEVERED RETURN OF CAPITAL			0	0	0	0	0	26,724,053
RETURN OF CAPITAL			0	0	0	0	0	16,343,775
Cash on Cash Return (Capital Only)			0.00%	0.00%	0.00%	0.00%	0.00%	52.15%

Figure 5.21

The ex post development proforma is shown below:

	DEVELOPMENT		OPERATIONS					
	Construction/Development							
	Sep-00	Dec-01	Dec-02	Dec-03	Dec-04	Dec-05	Dec-06	Dec-07
UNLEVERED ANALYSIS	4.0	12.0	2002	2003	2004	2005	2006	2007
DEVELOPMENT COSTS	(4,872,197)	(22,412,105)						
TOTAL CAPITAL COSTS			(658,377)	(1,462,500)	0	0	0	0
CASH AVAILABLE FROM HOTEL OPERATIONS			3,218,456	3,590,519	3,906,547	4,157,290	4,266,897	4,378,971
MISCELLANEOUS FEES & PAYMENTS			0	0	0	0	0	0
CAPITALIZATION RATE	10.5%							
SALES EXPENSE	1.0%							
TOTAL PROJECT CASHFLOWS	(4,872,197)	(22,412,105)	3,218,456	3,590,519	3,906,547	4,157,290	4,266,897	4,378,971
NET REVERSION PROCEEDS								41,287,439
UNLEVERED CASH FLOW	(4,872,197)	(22,412,105)	3,218,456	3,590,519	3,906,547	4,157,290	4,266,897	45,666,410
UNLEVERED IRR	18.38%	Cash on Cash	11.80%	13.16%	14.32%	15.24%	15.64%	16.05%
UNLEVERED RETURN OF CAPITAL			0	0	0	0	0	22,905,331
RETURN OF CAPITAL			0	0	0	0	0	18,382,108
Cash on Cash Return (Capital Only)			0.00%	0.00%	0.00%	0.00%	0.00%	67.37%

Figure 5.22

Discussion of Major Line Items in Ex Ante and Ex Post Proforma

Revenues

The ex ante projection of Year 1 NOI for this development project was approximately $3,449,000, or $18,248 per available room. First year occupancy was estimated at approximately 69.0%, allocated to 68,985 total rooms annually – resulting in 47,369 occupied rooms annually – at an expected average daily rate of approximately $142.50. The hotel is limited service, offering guests a restaurant for breakfast, and is primarily intended to serve business travelers. As a result, expected food and beverage revenues totaled approximately $8.50/occupied room/day. Communications and other revenue sources, including parking, were expected to total approximately $10.58/occupied room/day. Resultantly, RevPAR and RevPOR for the first year of operation were estimated at $110.96 and $161.59, respectively. The ex post first year NOI was $3,218,456, or $17,028 per available room. First year occupancy fell short of initial expectations at 66.0%, allocated to 68,985 total annual rooms – resulting in 45,530 occupied annual rooms – at an ADR of $144.10. Food and beverage revenues from first year operations exceeded expectations, totaling approximately $20.05/occupied room/year, while communications and other revenue sources totaled approximately $10.53/occupied room/year. RevPAR and RevPOR for the first year of operation were $115.25 and $174.63, respectively.

The property was expected to stabilize after the sixth year of operation, with annual occupancy of approximately 75.0%, ADR of $165.74, RevPAR of $140.19, and RevPOR of $186.92. Projected NOI for the sixth year of operation was estimated at $4,614,410. As expected, the hotel stabilized in the sixth year of operation, with annual occupancy of 76.0%, ADR of $169.08, RevPAR of $155.91, and RevPOR of $205.14. Realized NOI for the third year of operation was $4,378,971.

Hard Costs

The ex ante projection of hard costs for this development project, including land, was approximately $24,094,000, while the ex post proforma indicates actual hard costs for identical line items of approximately $21,911,800. Despite the apparent discrepancy between the estimated and realized hard costs, the finished development product was nearly identical in scope and in finish to the originally proposed hotel.

Aside from lesser actual hard costs incurred, the ex ante proforma illustrates construction draws spanning 18 months, beginning in May 1999, and concluding at the end of October 2000. In reality, as demonstrated in the ex post proforma, construction draws spanned only 16 months, from March September 2000 through December 2001.

Hard cost savings were realized by the developer when pricing for steel and framing was returned by the general contractor at discounts to ex ante forecasts of 8.4% and 12.3% respectively. Most other hard costs were accurately forecast, as much of the interior layout and finish specification was provided by the hotelier prior to construction. In order to maintain brand consistency and aesthetic continuity with other same-brand hotels operated by the hotel management company, many interior and exterior details were non-negotiable.

Soft Costs (including Furniture, Fixtures & Equipment)

The ex ante projection of soft costs – including FF&E, financing costs, pre-opening expenses, etc. – for Project #6 was $7,243,678 (an average of $38,326/key) , while the ex post actual soft costs equaled approximately $5,372,502 (an average of $28,426/key). This indicates an aggregate over-estimation of soft costs in the ex ante proforma of 25.83% when compared to the ex post results of actual soft costs incurred. The substantial overestimation of soft costs is caused in part by the shortened overall duration of the development transaction, mitigating insurance and construction interest expenses. Also, significant soft costs were eliminated during the financing of the project when realized lender fees and equity placement fees were less than originally forecast.

The FF&E package assigned to the developer by the hotelier was also consistent with other same-brand hotels, and ex ante projects were approximately identical to actual package costs. All decorative components of the hotel construction were purchased during the second year of construction in order to ensure procurement.

Cumulative Cashflows

A graph of cumulative cashflows for the development transaction follows:
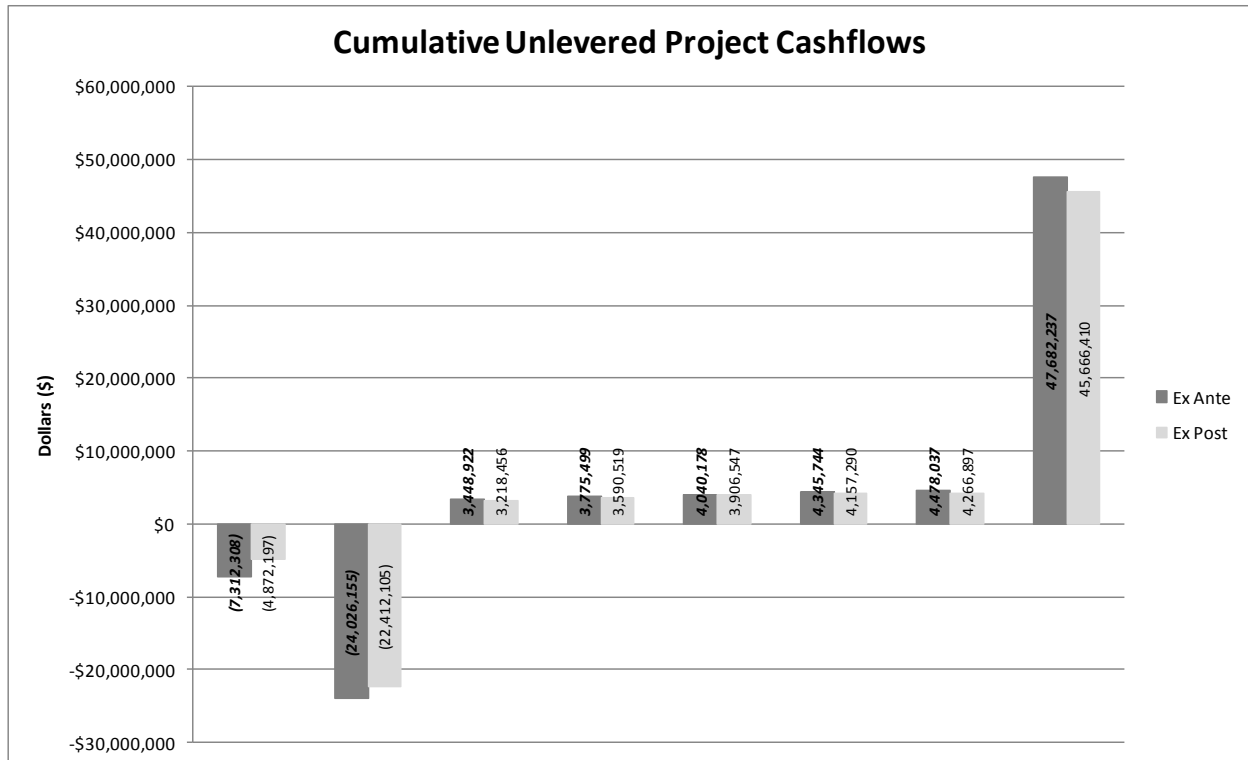
Figure 5.23

Total actual development transaction costs were reduced, both for hard costs and soft costs however realized annual NOI and reversion value were also reduced. In this instance, the developer recognized softening demand for hotel inventory in the market and was fortunate to recognize hard cost savings in the overall budget. The developer also took an active role in value engineering during the design and construction phases of the base building, and was able to closely monitor hard construction costs and financing and consulting soft costs.

According to the developer, a perceived advantage of hotel development is the pre-programming that occurs prior to entitlement and construction. Hard cost and soft cost overruns are less prevalent for pre-designed hotel inventory than for other speculative commercial development. Architectural and mechanical drawings are similar between hotels, and were provided to the developer at reduced cost at the time the operating agreement with the hotelier was executed.

We also observe that ex ante projected development commencement of May 1999 differed from ex post commencement in September 2000. Despite the miscalculation, transaction duration was estimated with

relative accuracy – ex ante predicted duration was 92 months, ex post actual duration was 88 months – as the hotel met little opposition from area neighborhood groups and the municipality. Tax revenues, added consumer base to fuel area retail sales, and the desired redevelopment of an under-utilized land parcel were attractive to area constituents.

PROJECT 7

Project #7 is a 131-key focused service mid-scale hotel located in an urban area in a secondary New England city. The project is five story steel and concrete construction with all hotel infrastructure, back-of-house, and amenities located on the ground floor of the building. The hotel is located immediately adjacent to a luxury condominium development, and provides guest services to the neighboring residents, including valet parking, room service, fitness facility membership, and pool/spa access. The site is located in a central downtown location, with premier access to a major interstate highway and auxiliary thoroughfares. Development costs totaled approximately $146,250 per key, of which approximately $83,049/key of total development cost was attributed to hard costs, $17,633/key to soft costs, $16,632/key to furniture, fixtures and equipment, and the balance to financing costs. Land and imputed equity were contributed by the developer following a revaluation of the property following re-entitlement. The revaluation was critical to sourcing the requisite construction loan for the project, and all imputed equity remained committed t to the transaction. Construction began during Q1 2005, and was completed in approximately 18 months, with delivery occurring during Q3 2006.

Equity Unlevered IRR & Deal Summary

	Ex Ante	Ex Post	% Difference
Year 1 NOI	$1,674,759	$2,305,046	37.6%
Stabilized Year NOI	$2,326,318	$2,563,704	10.2%
Capitalized Stable Year NOI	$25,589,503	$28,200,743	10.2%
Unlevered IRR	13.2%	19.5%	48.1%

Table 5.7

The ex ante development proforma is shown below:

		DEVELOPMENT			OPERATIONS			Stabilization
		Construction/Development						
		Dec-04	Dec-05	Feb-06	Feb-07	Feb-08	Feb-09	Feb-10
UNLEVERED ANALYSIS		1.0	12.0	2.0	2007	2008	2009	2010
DEVELOPMENT COSTS		(4,933,072)	(11,315,170)	(2,276,572)				
TOTAL CAPITAL COSTS					705,178	(742,353)	(780,253)	(820,088)
CASH AVAILABLE FROM HOTEL OPERATIONS					1,674,759	1,826,948	2,123,168	2,326,318
MISCELLANEOUS FEES & PAYMENTS					0	0	0	0
CAPITALIZATION RATE	9.0%							
SALES EXPENSE	1.0%							
TOTAL PROJECT CASHFLOWS		(4,933,072)	(11,315,170)	(2,276,572)	1,674,759	1,826,948	2,123,168	2,326,318
NET REVERSION PROCEEDS								25,589,503
UNLEVERED CASH FLOW		(4,933,072)	(11,315,170)	(2,276,572)	1,674,759	1,826,948	2,123,168	27,915,821
UNLEVERED IRR		13.16%		Cash on Cash	9.04%	9.86%	11.46%	12.56%
UNLEVERED RETURN OF CAPITAL					0	0	0	18,524,814
CAPITAL PROCEEDS AFTER RETURN OF CAPITAL					0	0	0	7,064,688
Cash on Cash Return (Capital Only)					0.00%	0.00%	0.00%	38.14%

Figure 5.24

The ex post development proforma is shown below:

		DEVELOPMENT			OPERATIONS		Stabilization
		Construction/Development					
		Dec-04	Dec-05	Aug-06	Aug-07	Aug-08	Aug-09
UNLEVERED ANALYSIS		1.0	12.0	8.0	2007	2008	2009
DEVELOPMENT COSTS		(3,497,741)	(6,382,269)	(8,966,886)			
TOTAL CAPITAL COSTS					(502,629)	(802,372)	(845,576)
CASH AVAILABLE FROM HOTEL OPERATIONS					2,305,046	2,316,838	2,563,704
MISCELLANEOUS FEES & PAYMENTS					0	0	0
CAPITALIZATION RATE	9.0%						
SALES EXPENSE	1.0%						
TOTAL PROJECT CASHFLOWS		(3,497,741)	(6,382,269)	(8,966,886)	2,305,046	2,316,838	2,563,704
NET REVERSION PROCEEDS							28,200,743
UNLEVERED CASH FLOW		(3,497,741)	(6,382,269)	(8,966,886)	2,305,046	2,316,838	30,764,447
UNLEVERED IRR		19.49%		Cash on Cash	12.23%	12.29%	13.60%
UNLEVERED RETURN OF CAPITAL					0	0	18,846,896
CAPITAL PROCEEDS AFTER RETURN OF CAPITAL					0	0	9,353,846
Cash on Cash Return (Capital Only)					0.00%	0.00%	49.63%

Figure 5.25

Discussion of Major Line Items in Ex Ante and Ex Post Proforma

Revenues

The ex ante projection of Year 1 NOI for this development project was approximately $1,674,000, an average of $12,779 per available room. First year occupancy was estimated at 68.0%, allocated to 47,815 total rooms annually – resulting in 32,514 occupied rooms annually – at an expected average daily rate of $136.00. Because the hotel is focused service, serving only breakfast, limited room service, and offering an abbreviated menu for lunch, food and beverage revenues were expected at approximately $19.38/occupied room/day. Communications and other revenue sources were expected to total approximately $6.33/occupied room/day. Resultantly, RevPAR and RevPOR for the first year of operation were estimated at $110.23 and $162.11, respectively. The ex post first year NOI was $2,305,000, or $17,596 per available room. First year occupancy exceeded expectations at 71.8%, allocated to 47,815 total annual rooms – resulting in 34,354 occupied annual rooms – at an ADR of $146.56. Food and beverage revenues totaled approximately $23.16/occupied room/year, while communications and other revenue sources totaled approximately $8.54/occupied room/year. Resultantly, RevPAR and RevPOR for the first year of operation were $128.06 and $178.24, respectively.

The property was expected to stabilize after the fourth year of operation, with annual occupancy of approximately 75.0%, ADR of $154.00, RevPAR of $136.24, and RevPOR of $200.35. Projected stabilized NOI for the fourth year of operation was estimated at $2,326,318 (an average of $17,758/key/year). The hotel, however, stabilized in the third year of operation, with annual occupancy of 78.0%, ADR of $155.46, RevPAR of $147.48, and RevPOR of $189.07. Realized stabilized NOI for the third year of operation was $2,563,700 (an average of $19,750/key/year). The developer argues that rapid

stabilization resulted from improved delivery timing (August 2006), as the summer and fall periods in the project submarket experience increased tourism. The area is heavily trafficked by "leaf peepers" during autumn, summertime beach-goers, and winter "snowbirds." The opportunity was attractive to the developer and hotelier, as the seasonal cyclicality experienced by many hotels was mitigated by the off-peak tourist activity.

Hard Costs

The ex ante projection of hard costs for the development, excluding contingency, was $10,225,000 (an average of $78,053/key), while the ex post proforma indicates hard costs, net of contingency, of approximately $10,495,645 (an average of $80,119/key). Despite the apparent discrepancy between the estimated and realized hard costs, overruns for the project were absorbed entirely by an ex ante estimated hard cost contingency of 6.40%, or $654,400. The remaining contingency on the ex post cashflow analysis was $383,755, resulting in both an ex ante and ex post total hard cost budget of $10,879,400. This indicates an accurate aggregate estimation of hard costs in the ex ante proforma when compared to the ex post results of actual hard costs incurred. Project #7 exemplifies the benefits of pre-programming involved in hotel development. The accurate hard cost budget resulted from the pre-selection and procurement of materials and FF&E consistent with other same-brand hotels.

A graphical representation of ex ante versus ex post hard costs for Project #7 follows:
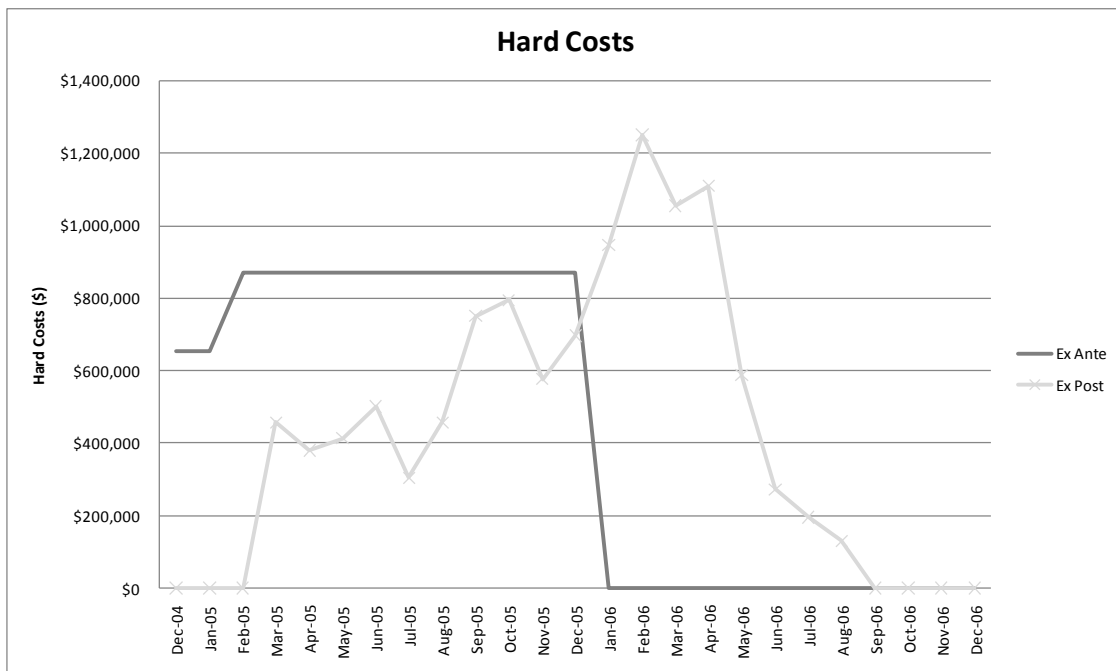
Figure 5.26

The chart illustrates diminished actual hard costs as the development transaction neared physical completion. It is evident, however, that two dramatic discrepancies exist between the ex ante and ex post trend lines; the timing of construction commencement and completion were dramatically underestimated in the ex ante proforma; and the overall duration of construction was inaccurately estimated. The ex ante proforma shows construction draws spanning 13 months, beginning in December 2004, and concluding at the end of December 2005. In reality, as demonstrated in the ex post proforma, construction draws spanned 18 months, from March 2005 through early August 2006. Delays in construction resulted from slowed progress during the cold weather months. Despite the impact on schedule, hard cost overruns were entirely absorbed by project hard cost contingency.

Soft Costs (excluding Furniture, Fixtures & Equipment)

The ex ante projection of soft costs for the development project was $1,954,638 (an average of $14,921/key), and ex post realized soft costs totaled approximately $2,309,888 (an average of $17,633/key). This indicates an aggregate under-estimation of soft costs in the ex ante proforma of 18.1% when compared to ex post actual soft costs incurred. The substantial underestimation of soft costs is partly caused by the extended overall duration of the transaction. Also, additional architectural and legal costs were incurred during an extended permitting process.

The following graph displays ex ante and ex post soft costs for the development transaction:
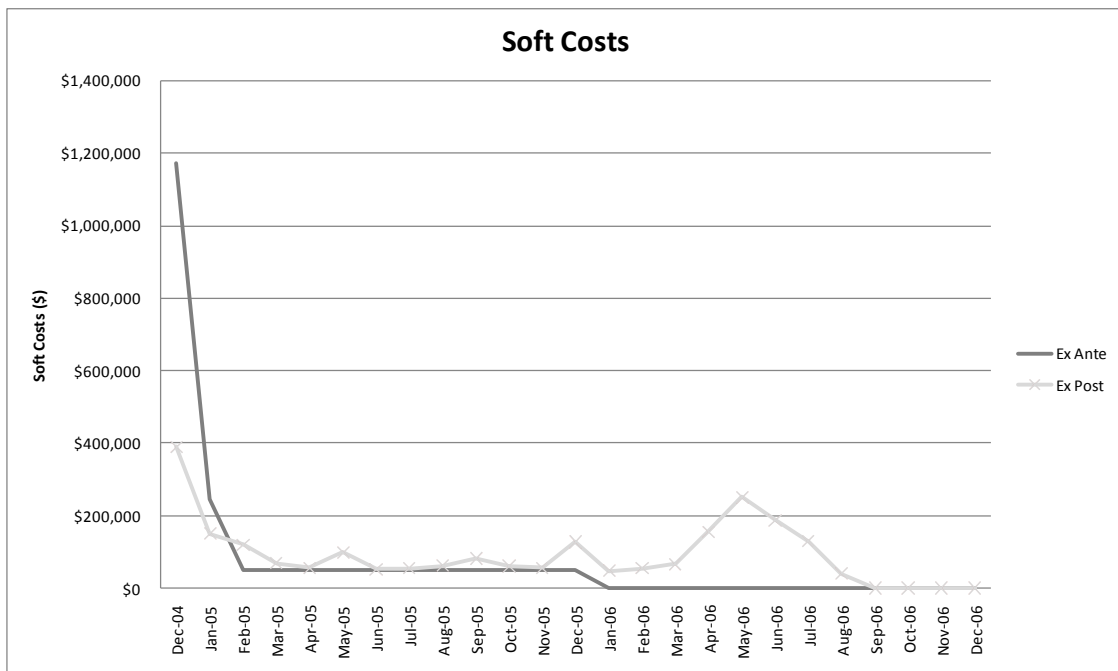
Figure 5.27

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It is also evident that actual soft costs incurred were more volatile in nature over the duration of the project than had been forecast. Additionally, however, the initial outlay for soft costs during the first month of the transaction was dramatically lower than expected ($390,216 ex post versus $1,172,783 ex ante). Original estimates suggest that most soft costs would be incurred during the design and permitting phases of the development, much of the actual expenditure of soft costs occurred during the construction phase, with a peak in outlay occurring near delivery of the project. The additional soft costs incurred can be attributed to the grand opening of the hotel, when the developer and hotelier collaborated on an elaborate celebration to introduce the hotel to the market.

Cumulative Cashflows

The following graph details ex ante and ex post cumulative transaction cashflows:
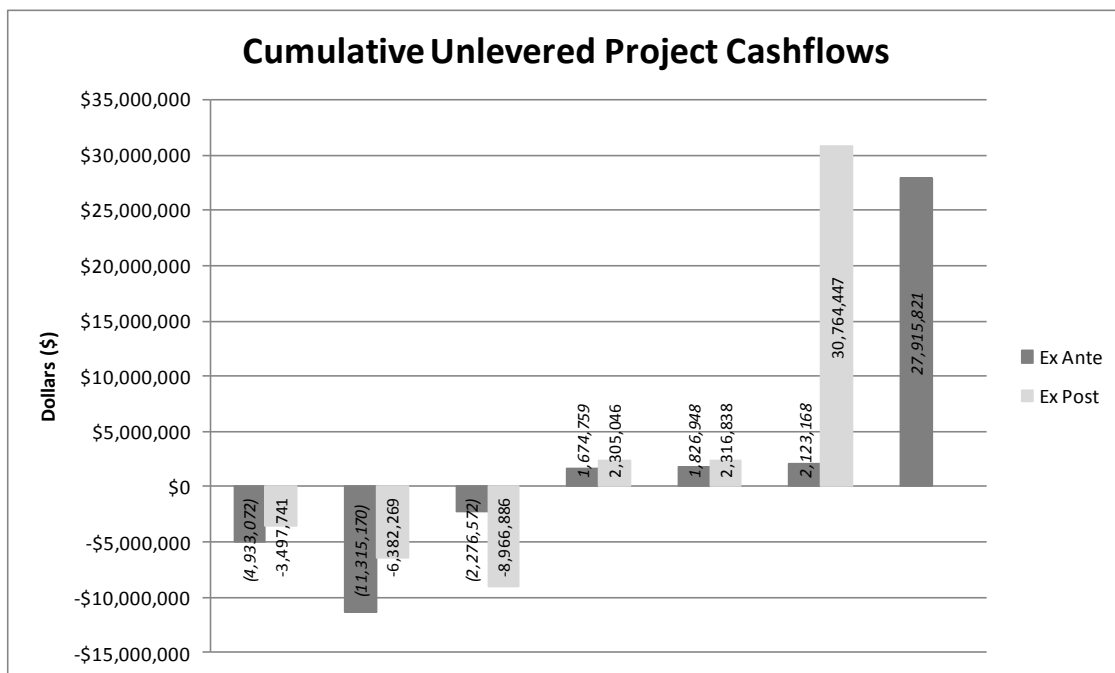
Figure 5.28

Despite a challenging permitting process, exacerbated by local residents wary that the proposed hotel would not conform to the architecture context of area historic buildings, the development out-performed IRR expectations by 48.1%. Schedule overrun, resulting in the successful delivery of the hotel during a peak time of the year, and NOI stabilization a year before ex ante projections were the cause of an ex post equity unlevered IRR of 19.5%. The improved stabilized year NOI enabled the developer to refinance the property at an appraised value of $28,200,743, exceeding the ex ante project expected reversion value of $25,589,503.

PROJECT 8

This development project is a 269-key, super luxury full service hotel located in an urban area in a primary western Unites States city. The high-rise structure is constructed of steel and concrete, with all hotel infrastructure, back-of-house, and amenities located on the first four floors and the ninth floor of the building. The hotel offers guests a premier luxury spa, butler service, a signature restaurant, unlimited access to outdoor terraces, well-appointed meeting space and boardrooms, art viewing rooms, ballrooms, and a conservatory. Guest rooms include standard rooms, suites, and a Presidential Suite. The project also includes approximately 100 luxury condominiums on the upper and penthouse floors of the building.

Condominiums were customized for buyers, resulting in hard costs and soft costs that exceeded ex ante projections. The developer approved the order of finishes on a unit-by-unit basis, affording homebuyers the opportunity to make substantial aesthetic changes, thereby sacrificing any economies of scale available on building material purchases. The developer also incurred excess development costs by building to a core and shell specification, excluding plumbing and mechanical cores, on condominium floors to allow prospective buyers an opportunity to modify unit layouts. Based on qualitative developer feedback, we conclude that the additional condominium unit design/construction flexibility accounted for nearly 60.0% of all cost overruns. The development transaction summary is shown in the below.

Equity Unlevered IRR & Deal Summary

	Ex Ante	Ex Post	% Difference
Year 1 NOI	$7,142,706	$8,136,502	13.9%
Stabilized Year NOI	$14,910,244	$13,108,706	-12.1%
Capitalized Stable Year NOI	$160,699,291	$129,776,194	-19.2%
Unlevered IRR	16.6%	11.9%	-28.3%

Table 5.8

Blended ex ante returns and costs are illustrated below:

	DEVELOPMENT				OPERATIONS/SALES			
	Months in Construction/Development				YEAR			Stabilization
	Dec-00	Dec-01	Dec-02	Dec-03	Dec-04	Dec-05	Dec-06	Dec-07
UNLEVERED ANALYSIS	1.0	12.0	12.0	12.0	2004	2005	2006	2007
DEVELOPMENT COSTS	(23,215,829)	(35,615,808)	(86,687,861)	(93,393,130)				
TOTAL CAPITAL COSTS	(75,000)	(5,778,157)	(10,463,628)	(1,955,072)	0	0	0	0
CASH AVAILABLE FROM CONDOMINIUM SALES					100,364,760	101,178,760		
CASH AVAILABLE FROM HOTEL OPERATIONS					7,142,706	12,084,638	14,457,377	14,910,244
MISCELLANEOUS FEES & PAYMENTS					0	0	0	0
CAPITALIZATION RATE	9.0%							
SALES EXPENSE	3.0%							
TOTAL PROJECT CASHFLOWS	(23,215,829)	(35,615,808)	(86,687,861)	(93,393,130)	107,507,466	113,263,398	14,457,377	14,910,244
NET REVERSION PROCEEDS								160,699,291
UNLEVERED CASH FLOW	(23,215,829)	(35,615,808)	(86,687,861)	(93,393,130)	107,507,466	113,263,398	14,457,377	175,609,535
UNLEVERED IRR	16.59%			Cash on Cash	45.00%	47.41%	6.05%	73.50%

Figure 5.29

The blended ex post development transaction proforma is shown below:

	DEVELOPMENT						OPERATIONS/SALES			
	Construction/Development									Stabilization
	Dec-00	Dec-01	Dec-02	Dec-03	Dec-04	Jun-05	Jun-06	Jun-07	Jun-08	Jun-09
UNLEVERED ANALYSIS	1.0	12.0	12.0	12.0	12.0	6.0	2006	2007	2008	2009
DEVELOPMENT COSTS	(24,840,829)	(23,288,525)	(33,032,533)	(103,457,669)	(82,945,365)	(14,937,114)				
TOTAL CAPITAL COSTS	0	0	0	0	0	0	0	0	0	0
CASH AVAILABLE FROM CONDOMINIUM SALES						125,368,450	126,473,450			
CASH AVAILABLE FROM HOTEL OPERATIONS						8,136,502	9,528,891	11,173,008	12,040,835	13,108,706
MISCELLANEOUS FEES & PAYMENTS							0	0	0	0
CAPITALIZATION RATE 10.0%										
SALES EXPENSE 1.0%										
TOTAL PROJECT CASHFLOWS	(24,840,829)	(23,288,525)	(33,032,533)	(103,457,669)	(82,945,365)	118,567,838	136,002,341	11,173,008	12,040,835	13,108,706
NET REVERSION PROCEEDS										129,776,194
UNLEVERED CASH FLOW	(24,840,829)	(23,288,525)	(33,032,533)	(103,457,669)	(82,945,365)	118,567,838	136,002,341	11,173,008	12,040,835	142,884,901
UNLEVERED IRR	11.90%				Cash on Cash	49.63%	56.93%	4.68%	5.04%	59.81%

Figure 5.30

Discussion of Major Line Items in Ex Ante and Ex Post Proforma

Revenues

The ex ante projection of Year 1 NOI for Project #8 was approximately $7,142,706, or $26,552 per available room. First year occupancy was estimated at approximately 67.8%, allocated to 98,185 total rooms annually – resulting in 66,523 occupied rooms annually – at an expected average daily rate of approximately $393.15. Provided the level of luxury afforded guests of the hotel and the costs associated with all hotel amenities, expected food and beverage revenue, including catered events and banquets, was forecast to total approximately $206.53/occupied room/day. Communications and other revenue sources, including parking, were expected to total approximately $44.58/occupied room/day. Resultantly, RevPAR and RevPOR for the first year of operation were estimated at $437.24 and $645.34, respectively. The ex post first year NOI was $8,136,502, or $30,247 per available room. First year occupancy fell short of initial expectations at approximately 60.0%, allocated to 98,185 total annual rooms – resulting in 58,950 occupied annual rooms – at an ADR of approximately $401.05. Food and beverage revenues from first year operations exceeded expectations, totaling approximately $164.70/occupied room/year, while communications and other revenue sources totaled approximately $29.11/occupied room/year. RevPAR and RevPOR for the first year of operation were $356.29 and $593.81, respectively.

The property was expected to stabilize after the fourth year of operation, with annual occupancy of approximately 76.5%, ADR of $486.02, RevPAR of $588.69, and RevPOR of $769.51. Projected NOI for the fourth year of operation was estimated at $14,910,244. As expected, the hotel stabilized in the fourth year of operation, with annual occupancy of 75.0%, ADR of $442.90, RevPAR of $488.61, and RevPOR of $651.48. Realized NOI for the fourth year of operation was $13,108,706.

Condo sales were expected to occur in the two calendar years following issuance of the certificate of occupancy, which official marked the completion of construction. Total net sales proceeds were expected

to be $201,543,520, or approximately $2,015,352 per dwelling unit. Ex post condominium sales occurred during the final year of construction – as permitted by receipt of a temporary certificate of occupancy – and in the year immediately following completion of construction. Aggregate sellout was $251,841,900, or approximately $2,500,000 per dwelling unit. Issuance of a temporary certificate of occupancy permitted the developer to execute purchase and sales agreements and close on approximately 49.8% of total condominium units. Resultant condominium proceeds, through June 2005, totaled approximately $125,368,450, buoying overall project returns.

Hard Costs

The ex ante projection of hard costs for the development project, excluding land, equaled approximately $145,264,453, while the ex post results totaled approximately $164,728,550. The discrepancy between estimated and realized hard costs is primarily the result of a modification to finishes in both the hotel and condominiums. Although hotel programming had been finalized prior to ground breaking, as it typical in hotel development, expensive custom upgrades to condominiums and hotel common areas exceeded all ex ante hard cost projections.

The ex ante proforma illustrates construction draws spanning 37 months, beginning in December 2000, and concluding at the end of December 2003. In reality, as demonstrated in the ex post proforma, construction draws spanned 55 months, March December 2000 through June 2005. Despite a consistent groundbreaking date, the construction schedule delays were due primarily to the substantial customization efforts in the luxury condominiums.

Soft Costs (including Furniture, Fixtures & Equipment)

Ex ante projection of soft costs (including FF&E, financing costs, pre-opening expenses, etc.) and acquisition for this development project was $93,648,176, while ex post realized soft costs totaled approximately $117,773,485. This aggregate under-estimation of soft costs in the ex ante proforma, compared to the ex post proforma, was 25.76%. The underestimation of soft costs is caused in part by the administrative fees and costs resulting from the lengthened overall development duration, and the additional costs associated with custom design, architecture and engineering expertise. Other reasons for soft cost overruns were additional community fees levied by the city against the developer, as well as significant increases of legal, and furniture, fixture, and equipment budgets.

A graphical representation of cumulative equity unlevered development transaction cashflows follows:
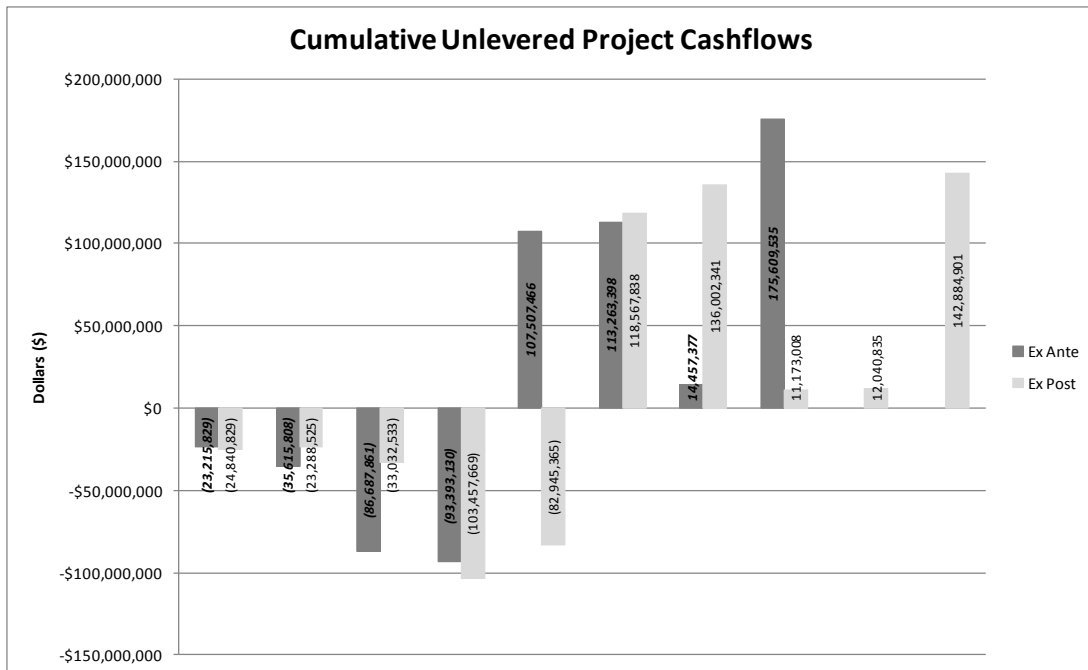
Figure 5.31

As illustrated above, overall costs for the development transaction increased, both for hard costs and soft costs, and realized annual NOI and reversion value were also reduced. Despite the marked increase in transaction duration, the blended overall returns were rapid condominium sellout at above-market prices per square foot. Both the pace of absorption of the condominiums and average sellout price per square foot were underestimated in the ex ante proforma. The hotel underperformed, despite stabilizing when expected, with weaker ADR, RevPAR, RevPOR, and NOI than had been originally forecast.

The customization of condominium units, in spite of weakened housing demand in the primary west coast urban market led to exceptional condominium sellout pricing. The developer was able to offset cost overruns to preserve an equity unlevered IRR of approximately 11.9%. It is interesting to note that although the pre-programming of hotel inventory often entails improved ex ante proforma accuracy, the hospitality component of the project negatively impacted overall project IRR. Refinancing of the mini-perm hotel loan, which occurred in Q2 2009, was based on an ex post derived value of $129,776,194. The ex ante expected reversion/recapitalized value equaled $160,699,291, which exceeded actual stabilized value by 23.8%. Mini-perm loans are a financing mechanism for commercial properties that need to establish an operating history prior to obtaining long term permanent financing. It is a short term

financing solution, usually three to five years to maturity, used to pay off construction or commercial property loans.[17]

In this chapter we explored the details of development transaction details, and we have highlighted the impactful exogenous an endogenous variables that impacted equity unlevered returns. Each of the eight transactions analyzed were influenced by a number of unforeseen issues. It was particularly interesting to recount the ways in which each developer chose to react to or preempt the issues in order to preserve transaction values. A detailed summary of all analyzed transactions is provided in Chapter 7, where we endeavor to examine trends in the results.

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[17] <http://www.businessfinance.com/mini-perm-loan.htm>

Chapter 6 – Conclusion of Ex Ante and Ex Post Analysis

6.0 Do Developers Accurately Project Real Estate Development Returns?

The first question we attempt to answer is: using standard DCF analysis as a measurement tool, are developers accurately projecting real estate development returns? We can answer this question by comparing ex ante and ex post IRR for each of the studied real estate development deals. Figure 6.1 summarizes the ex ante and ex post IRR for each deal.

	Equity Unlevered IRR	
Project	**Ex Ante**	**Ex Post**
1	26.80%	1.00%
2	31.60%	27.30%
3	31.01%	16.30%
4	34.70%	-17.40%
5	15.78%	-1.57%
6	15.97%	18.38%
7	13.16%	19.49%
8	16.59%	11.90%
Average	**23.20%**	**9.43%**
VW Average	**18.09%**	**11.69%**

Figure 6.1

Based on the data analyzed, the short answer is: no. Developers appear to be overly optimistic in their projections.

As Figure 6.1 indicates, there is an overall average ex ante IRR projection of 23.2%, while the ex post average return totaled 9.43%. This indicates a spread between ex ante and ex post of 1,378 basis points. The weighted average indicates an ex ante IRR of 18.09%, and an ex post IRR of 11.69%. Of course, both data points show a substantial spread between the ex ante projection and ex post results.

There were a total of eight deals analyzed. Of those eight deals, 6 ex post IRR were lower than their ex ante counterpart IRR; two exceeded the ex ante return. Looking more closely at the data, we find that, of the eight deals analyzed, four of the eight ex post results were within 500 basis points of the ex ante projection. However, even a spread of 500 basis points can be viewed as a significant difference between anticipated and actual returns.

This coincides with findings detailed in a research paper by Dr. Jim Shilling, entitled "Is There a Risk Premium Puzzle in Real Estate?" In his paper, Shilling analyzes ex ante and ex post real estate returns for

institutional stabilized real estate assets and finds "an *ex ante* risk premium on real estate of about 6-6.75%, which is too large to be explained by standard economic models." We find an ex ante premium on real estate *development* of approximately 18.75%.[18] The fact that the ex ante premium for real estate development deals is higher than the ex ante premium for institutional stabilized real estate is to be expected. This is because real estate development involves significantly greater risk than stabilized institutional real estate investments.

The aforementioned research paper, "Is There a Risk Premium Puzzle in Real Estate?" analyzes if there are different risk premia applied to four different property types; office, retail, apartment, and industrial (again analyzing stabilized institutional real estate). Shilling finds that "all four expected risk premiums are in the range of 6.0% to 6.75%, highlighting the fact that compensating premium does not vary significantly across different property types." We find, based on a small sample size, a different result for real estate development. The chart in Figure 6.2 shows ex ante and ex post IRR broken down per property type:

Equity Unlevered IRR by Product Type		
Project	Ex Ante	Ex Post
1 - Residential	26.80%	1.00%
2 - Residential	31.60%	27.30%
3 - Residential	31.01%	16.30%
4 - Residential	34.70%	-17.40%
5 - Residential	15.78%	-1.57%
Average Residential	27.98%	5.13%
VW Average Residential	29.11%	3.22%
6 - Hotel	15.97%	18.38%
7 - Hotel	13.16%	19.49%
8 - Hotel	16.59%	11.90%
Average Hotel	15.24%	16.59%
VW Average Hotel	16.35%	12.84%

Figure 6.2

The ex ante IRR for residential development has an overall average of 27.98%, while the ex ante IRR for hotel has an overall average IRR of 15.24%, a spread of 1,274 basis points. Our study finds that residential real estate developers require a higher risk premium than hotel developers, and it can therefore

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[18] The risk premium is based on the return yielded in excess of the risk-free rate. The risk-free rate is usually defined as a treasury note that is backed by the full force of the United States government. The risk-free rate used in this calculation is 4.45%, which represents the average of the 10-Year U.S. Treasury bill rates for the years 2004 to 2006 (4.27%, 4.29%, and 4.80%, respectively). These three years were chosen because they represent that time period in which the majority of analyzed real estate development transactions took place.

be inferred that developers perceive the risk of residential condominium development projects to exceed that of hotel projects.

This is an interesting and finding in that developers typically perceive hotel development projects to be riskier than residential condominium projects. However, these results suggest otherwise. The authors present one such possible reason for this finding: the hotel development projects were developed for a 'flag,' or major hotel operator. These large hotel operators bring a breadth of experience to the deal, and typically customize and 'commoditize' much of the design process. They typically produce very similar products and have long-standing relationships with many third party firms involved in the development process, including architects, designers, engineers, contractors, etc. It is thought that this expertise and experience mitigates much of the risk involved with hotel development, and therefore the required risk premium is not as significant as that required by residential condominium developers.

Also interesting is that the spread between ex ante projections and ex post returns was significantly lower in the hotel development projects than the residential development projects. The spread between ex ante and ex post overall averages was 2,285 basis points for residential projects and 351 basis points for hotel projects. We hypothesize the same logic presented above may explain why the spread for hotel projects was significantly smaller than for residential projects.

If this hypothesis is correct, it could be assumed that developers can project returns more accurately. The data suggests that with extensive experience, established relationships with third parties, and perhaps a more 'commoditized' product like hotels, real estate development projections can be improved.

6.1 Where are Developers Going Wrong?

Now that we know that ex ante real estate development proformas are typically inaccurate, the next question we attempt to answer is: If ex ante and ex post IRR are different for each real estate development deal, is there a consistent mistake that developers make? Asked differently, where were errors made in input variable estimations for the ex ante DCF analyses?

In order to answer this question, we look to discrepancies in the number and timing of the major line items of the ex ante and ex post proforma. We assess net sales revenues, hard costs, and soft costs. The chart in Figure 6.3 shows the difference, in percentage terms, between each of these budget items in all ex ante and ex post proformas.

PERCENTAGE DIFFERENCE IN AGGREGATE EX ANTE AND EX POST				
Project	IRR	Net Sales Revenue*	Hard Costs	Soft Costs
1	-96.3%	16.70%	-49.60%	-35.20%
2	-13.6%	-7.60%	-4.30%	4.90%
3	-47.4%	-7.00%	-32.00%	-36.80%
4	-150.1%	21.20%	-16.30%	-27.70%
5	-109.9%	-6.96%	-15.61%	-26.86%
6*	15.1%	6.68%	-9.96%	-34.83%
7*	48.1%	-9.26%	-2.58%	-18.17%
8*	-28.3%	13.74%	-13.40%	-25.76%
Average	-47.8%	3.44%	-17.97%	-25.05%

● Over-estimated   ◆ Under-estimated

*For Projects 6,7, & 8 (hotel transactions), Stabilized NOI is used in place of Net Sales Revenue

Figure 6.3

Figure 6.3 reveals some interesting patterns. The residential condominium deals (Deals 1-5) return varied results. Three ex ante proformas under-estimated net sales revenue, while two over-estimated net sales revenue. A similar pattern emerges for the hotel development deals (Deals 6-8). Two proformas over-estimated Stabilized NOI and one deal under-estimated the Stabilized NOI.

The errors in estimation were dispersed. The eight deals analyzed averaged 344 basis point difference in revenues between the ex ante and ex post proformas. While a 344 basis point spread between ex ante and ex post may not initially appear alarming, a closer look at each deal shows an incredibly wide dispersion from the mean. In some cases, developers were off as much as 2,100 basis points. While standard deviation is not an appropriate metric to use in a case study method which analyzes only eight development deals, we feel it is important to note that the average may be misleading.

We also find that when developers over-estimate net sales revenue, they do so much more aggressively. However, when they under-estimate net sales revenue, the error of estimation is done so much more conservatively. For example, the above chart shows four over-estimations and four under-estimations of net revenues. The four overestimations were 16.7%, 21.2%, 6.68%, and 13.74%, with an average of 14.58%. The underestimations were 7.6%, 7.0%, 6.96%, and 9.26%, with an average of 7.05%.

The results indicate a wide difference in net revenues and lead us to believe that more due diligence may be applied in the projection of revenues in order to more accurately project ex ante revenues. Further, the

fact that over-estimations were generally much greater than under-estimations leads us to believe that developers may be overly optimistic in their ex ante projections of net revenues.

We next focus on the cost side of the real estate development proforma. Interestingly, developers under-estimated hard costs for each project. The under-estimation ranged from 2.58% to 49.6%, with an average underestimation of hard costs of approximately 17.97%. In the analysis of soft costs, we can see that in almost every case (Project #2 is the only exception) developers also underestimated soft costs. It can be concluded that developers are consistently under-estimating hard costs in the ex ante development proformas, and more thorough underwriting efforts for estimation of hard costs is necessary.

Finally, we analyzed the timing of the cashflows for each of the major proforma line items: net sales revenues (or Stabilized NOI for hotels), hard costs, and soft costs. Timing is a necessary element to consider when evaluating a real estate development deal, particularly when using the IRR, which is a time-sensitive return measure. The following chart compares timing, in months, between the ex ante and ex post proforma for each of the focal budget line items.

DURATION COMPARISON (MONTHS)		Net Sales Revenue	Hard Costs	Soft Costs
Project				
1	Ex Ante	14.0	4.0	14.0
	Ex Post	31.5	31.0	32.5
	Delta	**17.5**	**27.0**	**18.5**
2	Ex Ante	20.2	12.7	20.2
	Ex Post	18.3	13.2	18.3
	Delta	**-1.9**	**0.5**	**-1.9**
3	Ex Ante	15.2	10.1	23.4
	Ex Post	23.4	21.3	30.5
	Delta	**8.2**	**11.2**	**7.1**
4	Ex Ante	17.3	13.2	17.3
	Ex Post	21.3	19.2	24.3
	Delta	**4.0**	**6.0**	**7.0**
5	Ex Ante	26.0	10.0	22.0
	Ex Post	36.0	15.0	36.0
	Delta	**10.0**	**5.0**	**14.0**
6*	Ex Ante	90.0	18.0	19.0
	Ex Post	88.0	16.0	17.0
	Delta	**-2.0**	**-2.0**	**-2.0**
7*	Ex Ante	63.0	13.0	14.0
	Ex Post	57.0	18.0	19.0
	Delta	**-6.0**	**5.0**	**5.0**
8*	Ex Ante	85.0	37.0	38.0
	Ex Post	103.0	55.0	56.0
	Delta	**18.0**	**18.0**	**18.0**

*For Projects 6, 7, & 8 (hotel transactions), time to Stabilized NOI is used
in place of time to sellout

Figure 6.4

Figure 6.4 presents a comparison of the durations (in months) of cost and revenue budget line itmes between the projected ex ante and ex post proformas. For example, the developer of Project 1 estimated it would take 14 months from the first cash outflow to realize all revenues. In fact, it took 31.5 months, a difference of 17.5 months.

We can summarize some interesting findings from Figure 6.4 as follows:

Timing of Net Revenues

- Under-estimated 5 of 8 times (62.5%)
- Average over-estimate: 3.3 months
- Average under-estimate: 11.5 months

The data suggests, again, developer optimism, in that developers typically under-estimate the time it takes to realize net revenues by nearly one full year. Developer optimism seems prevalent in the data for hard and soft cost timing as well.

Hard Costs

- Under-estimated 7 of 8 times (87.5%)
- Average under-estimate: 10.4 months

Soft Costs

- Under-estimated 6 of 8 times (75.0%)
- Average under-estimate: 8.2 months

6.2 Overall Conclusion

The data from the case studies emphasize that developers of each of the eight transactions are optimistic in making all projections. The cases showed an average unlevered ex ante IRR of 23.2% while the ex post results showed an average unlevered IRR of 9.43%. Errors in estimation of aggregate numbers occurred most predominately in estimation of hard costs and soft costs. Hard costs were consistently under-estimated with an average of 17.97%, and soft costs were under-estimated and averaged 25.07% lower than the ex post results. Finally, developers were also overly optimistic in timing of cashflows. The number of months to realize all net revenues, hard cost, and soft costs were consistently under-estimated, with an average of 5.98 months, 8.84 months, and 8.21 months, respectively.

If one believes that the sample size is representative of the whole, we can establish that developers are optimistic in making projections. Given the discrepancies between the ex ante and ex post proformas, particularly regarding the spread in returns, we explored another method to add additional layers of information and alternative sensitivity analysis to development proformas to decrease return spreads between proformas to improve the development projection process.

Chapter 7 – MCS Methodology

7.0 Methodology

This chapter will explore if Monte Carlo Simulation can serve as an additive analysis method, in order to apply additional layers of sophistication to the ex ante development proforma. Due to the discrepancies in ex ante and ex post proformas as discussed in Chapter 6, we explored the application of MCS to the ex ante proformas to better inform the analyst of the risks of a particular project. In order to do so, we are using a program called @Risk, Version 5.0. While there are several software packages available that allow data analysis through MCS, @Risk works as an add-in to Microsoft Excel, including the DCF proformas provided to us by our participant real estate developers.[19]

There are several necessary and important steps in performing MCS. First, a user must define an output. This is the variable in a spreadsheet the user wants to test, or 'watch' for changes in the results. For purposes of this thesis, we wanted to test the impact on IRR based on changes in other variables. The IRR is typically used by real estate developers to determine if a project is worthy of pursuit. It is for this reason that we have assigned the IRR as our output. In fact, the concept of testing the impact of variables on an output variable (IRR) is not new. Most sophisticated developers already do this for certain variables of concern, in a process called 'sensitivity analysis.' In a typical sensitivity analysis, or "what-if analysis", a developer may test a downside scenario, an expected outcome, and an upside scenario. However, this version of sensitivity analysis still requires deterministic (point estimate) values to be assigned to variables in the DCF. The typical sensitivity analysis does not provide the probability of such events occurring. It is for these two reasons, among others, that MCS may be able to offer additional information and levels of sophistication to the DCF analysis process, and the reason it is explored further in this thesis research.

Next, a user must decide which variables to apply a range of values to in the DCF. Any number of variables may be assigned a range of values in a DCF. The decision for a developer of which variables to assign a range of values should be based on those variables that he is most concerned about; those variables that may have the greatest impact on the IRR when changed. The variables may very well be different for each development depending on the specific items of concern for a particular development project. Variables may also change depending on position in the market cycles, location, property type, and any other number of reasons that might matter for a particular development type (i.e. subsoil

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[19] Additionally, MCS can be modeled in Microsoft Excel without the use of an add-in software package. The interface on such software packages makes the execution of MCS more intuitive and simplistic.

conditions may be of particular concern in some development projects while the success of another development might be particularly dependent on length of entitlement period).

There has been some research on the variables in a real estate proforma that may have the greatest impact on IRR. Such methods are typically referred to as 'performance attribution.' A paper entitled, "IRR-Based Property Level Return Attribution" describes the process of quantifying the different components of a real estate IRR between initial yield, cashflow change, and yield change.[20] While this thesis does not intend to focus on performance attribution as related to real estate development, such methods do exist. Further, it has been generally found that the terminal value of the project (i.e. the sales price after the holding period for a real estate investor) typically has the greatest contribution to the overall IRR.

To better illustrate the concept of choosing variables for MCS, consider the developer of a condominium project in Boston. He might decide to apply a range of values to sales price per square foot and entitlement period. This developer might know the difficulties found in the Boston entitlement process and know that is a particular concern for him in the success of this development project. The developer would also know that the sale price per square foot is a critical and important variable with respect to its impact on project IRR. Therefore, the developer may decide to test these two variables. This developer may test any number of variables he wishes in MCS.

It is critical to note that whenever more than one variable is being tested using simulation, the analyst must consider co-movement between the variables, or if such a co-movement exists. Co-movement, defined in statistics as correlation, is a means for expressing the linear movement of one variable relative to another. Measures of correlation range from -1.0 to 1.0, indicating both direction and strength of the variable co-movement. The coefficient itself is generated by using a best-fit line on a scatter plot on which one variable is plotted along each axis. The slope of the best fit line is a quantitative representation of the relationship between the two distinct, independent variables. When the correlation coefficient is 0.0, we would conclude that there is absolutely no relationship between the variables, and that the movement of one particular variable is altogether unexplained by the movement in another. When correlation coefficient equals 1.0, the variables move in lockstep upward or downward. They move in the same direction, and percentage change in one variable is mirrored by the other. When the correlation coefficient equals -1.0 the variables move in opposite directions with matching strength of change. More specifically, when one variable increases 10.0%, the other will simultaneously decrease 10.0%.

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[20] Geltner, David. "IRR-Based Property-Level Performance Attribution." The Journal of Portfolio Management (Real Estate Issue. June 2003.

Once a developer has chosen the variable inputs to which apply a range of values, he must next choose how to assign those ranges of values. This may be done a variety of ways. One, a developer may use intuition to gauge the probability of outcomes. For example, the developer of an office building might reason that rents will likely be $40.00 per square foot. However, he may recognize that there is a 50.0% chance rents will be $30.00 per square foot. He may also recognize that there is a 25.0% chance that rents will be $48.00 per square foot. Armed with this information, ranges for variables may be selected and a probability distribution may be assigned to the relevant and important variables.

Although a developer familiar with a market may use intuition in deciding the range of values for particular variables, an alternative approach would include utilizing market research using a variety of sources. Market data and information is readily available from numerous local and national brokerage houses, including Colliers, Cushman and Wakefield, CB Richard Ellis, Torto Wheaton Research (TWR), Reis, RC Analytics (RCA), and Property and Portfolio Research (PPR) among many others. Comparable sales analysis, using market data, can inform the analyst or developer to the minimum and maximum rent levels, average rent levels, appropriate market vacancy, market absorption rates, etc. The more robust and comparable the data set, the better.

Once data is gathered, it can be analyzed to determine expected minimum and maximum rent levels, and to form probability distributions to define the potential range of values for variables. MCS will then run a number of iterations, using randomly generated numbers for each selected variable within its assigned probability distribution.

The selection of shape of the probability distribution for each variable is an important task. One can define probability by assigning one of many distribution shapes. These may include the most commonly used 'normal distribution,' or one of many, many others that indicate various weighted probabilities. They can be adjusted to reflect different 'tail' length or thickness.

There are several factors that should influence the selection of the appropriate probability distribution shape. These may include:

- Historical data collected from various sources
- The position (i.e. time frame) in the market cycle in which the development is anticipated to occur

For example, if a developer believes that rents will be $40.00 per square foot (the mean), and he believes there is an equal probability of rents dropping to $35.00 per square foot or increasing to $45.00 per square

foot, then that developer might choose a normal probability distribution to assign to the 'rent' variable in a proforma. A normal distribution shape looks like this:
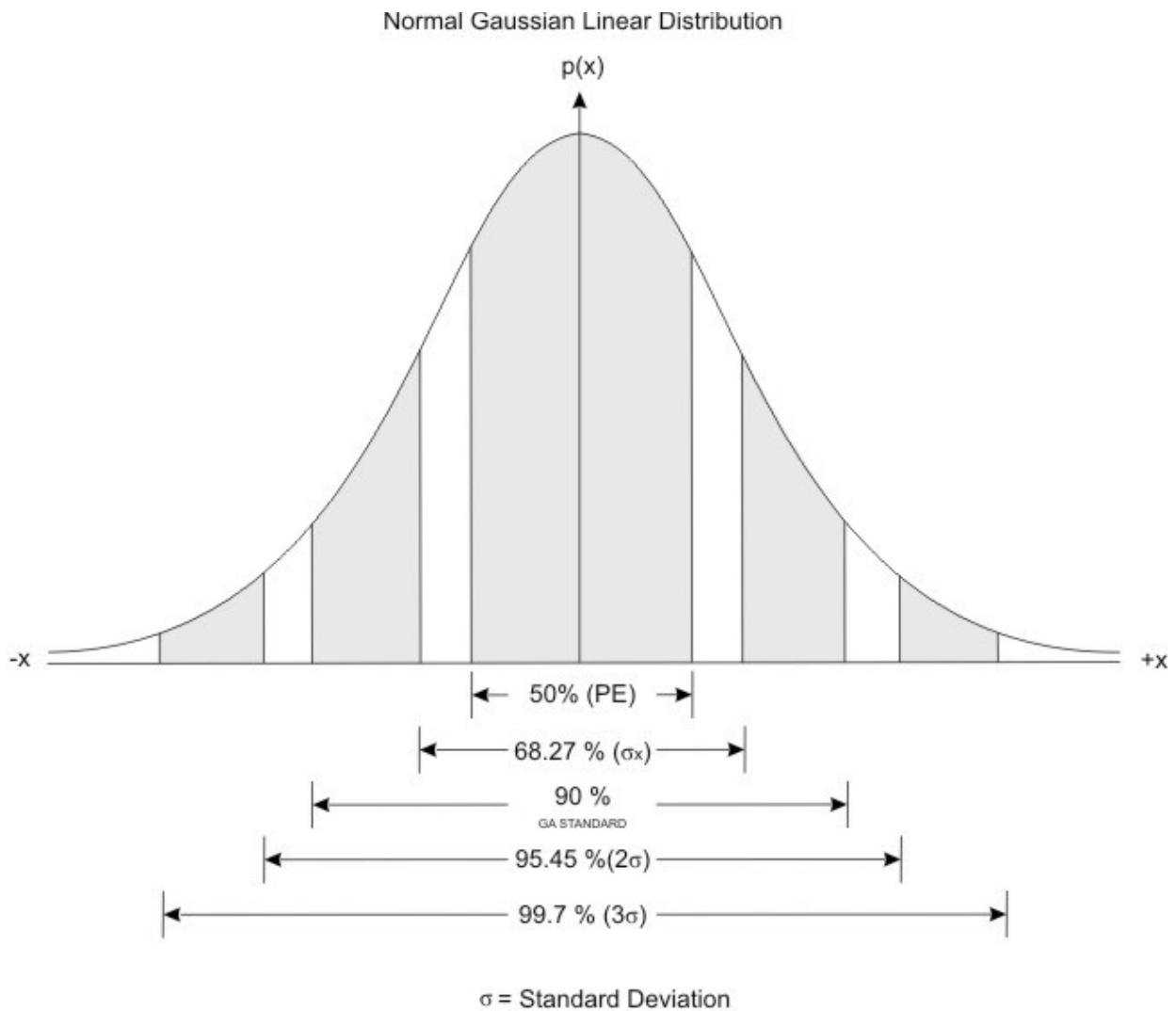
Figure 7.1

Source: Australian Government, Geosciences

The area bracketed between the 50.0% confidence interval (between -1σ to 1σ; the Greek letter sigma (σ) is used to denote standard deviation in statistics) is one standard deviation in either positive or negative direction from the mean. For a Gaussian normal distribution, as depicted above, this accounts for approximately 68.2% of the entire data set, and can otherwise be referred to as the 68.2% confidence interval. Two standard deviations in either direction from the mean (-2σ to 2σ) account, collectively, for

about 95.4% of all values in the distribution, and three standard deviations (-3σ to 3σ) removed from the mean in each direction together account for about 99.7% of probable values in the distribution.[21]

The normal distribution may, arguably, be more applicable when there is a normal market; that is, when the market is exhibiting stable performance, not particularly strong or poor. However, if a developer believes the market is below the mean or above the mean, he might choose a different probability distribution to assign to certain variables in the proforma.[22]

A developer might rely upon one of several real estate indices to gauge what point in a market cycle a given development is taking place, at a given time. This information will better inform his selection of probability distributions. If he knows the market is near the peak, he might select a probability distribution that allows for a greater probability that rents will be lower than the mean. Conversely, if a developer thinks the market is near a low, he may wish to reflect that knowledge in a probability distribution that allows for a greater probability that rents will be above the mean. There are several real estate market indices available to the general public for which to base this knowledge. Perhaps most notably, the National Council of Real Estate Investment Fiduciaries (NCREIF) publishes the NCREIF Property Index (NPI). The NPI consists of both equity and leveraged properties, but the leveraged properties are reported on an unleveraged basis. So, the index is completely unleveraged. The NPI is published quarterly and is appraisal-based rather than transaction-based.

Another such index for which to base point in the market cycle is the Transaction-Based Index (TBI) as published by the MIT Center for Real Estate. The TBI is a quarterly index that measures market movements and returns on investment based on transaction prices of properties sold from the NCREIF Index database. Therefore, it does not rely on appraisal-based methods.

The Case Shiller Index is another notable index for certain property types. Focused primarily on residential product types, Cash Shiller produces indices for single family homes and condominiums.

It might also help to recognize cycle duration while making decisions based on real estate indices such as NCREIF or TBI. Such information can provide a general overview of how long typical real estate market cycles are, and when the 'peak' or 'trough' of a particular market cycle might occur. There has been much published data on the length of real estate cycles; data exists to support cycles as short as 2-3 years

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[21] < http://en.wikipedia.org/wiki/Normal_distribution>
[22] Proponents of efficient markets (Efficient Market Hypothesis) would argue that a normal distribution would be appropriate in all cases. Others argue that real estate is not an efficient market and thus a normal probability distribution is not always appropriate.

and as long as 100 years. In general, researchers think the typical U.S. residential real estate market cycle, from peak to peak (or trough to trough) lasts approximately 14-18 years.[23]

Although not an exact science, a developer may be able to accurately assess the appropriate probability distribution to apply to variables in a proforma based on indices data. In order to illustrate this concept, consider a developer who is developing a project in late mid 2007. Based on the NCREIF, TBI, or Case Shiller index, he could reasonably expect that the market is at or near its peak. Therefore, if he thought the mean rent was $40.00, as in our previous example, he would choose a probability distribution that will allow for a greater percentage chance that rents will fall to $30.00 and less probability that rents will increase to $45.00.

Perhaps more intuitive is the ability of a developer to construct his own probability distribution based on answering some questions that he might already intuitively know. For instance, a developer might be able to describe with some certainty the likely outcome of rents, making such statements as:

- I think rents will be $40.00per square foot

- There is a 20.0% chance rents will be under $35.00 per square foot

- There is a 40.0% chance rents will be under $40.00 per square foot

- There is an 80.0% chance rents will be under $50.00 per square foot

- There is a 100.0% chance rents will be under $51.00 per square foot

Armed with such information, which might be more intuitive for a non-statistically sophisticated investor, one may calculate a probability distribution for which to base value ranges to the chosen variables.   This method can be performed over and over for each variable (for rents, vacancy, operating expenses, etc.) to determine the shape of the probability distribution.

Finally, once the variables have been selected for which to apply MCS and a probability distribution has been selected using information such as historical information, point in the real estate cycle, and qualitative assessment, a user of MCS must decide how many scenarios they wish to generate. Literature

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[23] Foldvary, Fred E. "Real Estate and Business Cycles: Henry George's Theory of the Trade Cycle." *References:*
    Hoyt, Homer. According to Hoyt: 53 Years of Homer Hoyt. n.p.: n.p., 1970.
    Sakolski, A.M. The Great American Land Bubble. New York: Harper & Brothers, 1932. Report. 1966.
    Hicks, John D. Rehearsal for Disaster: The Boom and Collapse of 1919-1920. Gainesville: University of
        Florida Press, 1961.
    English, John Wesley, and Gray, Emerson Cardiff. The Coming Real Estate Crash. New Rochelle, New
        York: Arlington House Publishers, 1979.

exist that states the standard error of MCS will be reduced through a greater number of iterations.[24] However, the limits to running a large number of iterations have been drastically reduced with improvements in modern computing. With the sophistication of modern computers and software, the ability to process thousands of iterations of MCS can be done in a very short amount of time. Therefore, there is no reason not to run thousands of iterations. Generally 1,000 to 5,000 iterations is more than statistically significant and takes little time. For example, a simple 5,000 iteration simulation takes under 20 seconds to run.

Using this methodology, we will apply MCS to a real-world development project. We will seek to assess the potential merits of MCS to real estate development projections, and hope to narrow the spread between the ex ante IRR and the ex post results.

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[24] Boyle, Phelim. "Options: A Monte Carlo Approach." Journal of Financial Economics IV. North Holland Publishing Company. 1977: Pages 323-338.

Chapter 8 – Deal-Specific Monte Carlo Simulation Exercise

8.0 Selection of The Deal

We will now apply Monte Carlo Simulation to a specific deal to analyze the merits and added layer of information MCS may be able to provide the development analyst. We have chosen a deal previously analyzed in our ex ante and ex post analysis. This allows us to compare the ex ante return projections and associated probabilities using MCS to the ex ante projections using the developer's original DCF analysis. Additionally, we will compare the ex ante MCS IRR to the ex post returns to see if MCS, if used, would have provided more meaningful information to inform the 'go-ahead' development decision.

The deal, Project #5, is a small condominium project located in an urban area of a primary New England city. The selection was random, and was not predicated on product type, location, etc. In order to more thoroughly explore simulation we have elected to focus our effort on one case study rather than performing a more superficial study of each of the collected cases.

8.1 Output Selection

Consistent with the ex ante and ex post analysis discussed and demonstrated in previous chapters, we have elected to use the equity unlevered IRR as the proposed output for the simulation trial. Utilizing the original ex ante DCF proforma for the selected deal, we witness an original forecast of 15.78%.

8.2 Input Selections

In the simulation exercise outlined herein, two inputs were chosen that were impactful to the IRR: sellout velocity (in this instance, sellout of condominiums); and average sellout price per square foot.

Inputs for the simulation exercise were selected based on their impact on the unlevered IRR. These variables were determined in our exercise through two main sources:

1. Developer feedback in this particular transaction
2. Variables to which academics and practitioners attribute much of the overall transaction IRR.

Average Sellout Price per Square Foot

In our analysis, we use the exact same data that the developer used in making his ex ante projections. The data, provided by the brokerage firm ultimately employed to sell the units upon completion of construction, excludes units then under contract, or those currently for sale. This data, exclusively, was

utilized by the developer for initial ex ante proforma unit pricing. This data indicated the average sellout price per square foot for all market rate units was approximately $393.04. The value was based on comparable condominium sales (69 total sales) in the relevant submarket from the six months prior to creation of the ex ante proforma. The original comparable sales data is summarized and displayed in Figure 8.1.

	Price/SF
Minimum	$288.11
Maximum	$563.38

Sellout Spectrum (Price/SF)	
Lower Limit	$362.73
1st Third	$398.37
2nd Third	$416.17
Upper Limit	$563.38

Spectrum Info	Unit Count
1st Third	23.0
2nd Third	23.0
3rd Third	23.0

Unit Averages	Price/SF
1 Bedroom/Studio	$414.79
2 Bedrooms	$390.47
3 Bedrooms	$364.05

Unit Averages	Unit Size (SF)
1 Bedroom/Studio	695.7
2 Bedrooms	985.1
3 Bedrooms	1373.6

Figure 8.1

Disaggregate market comparable data is listed below the following charts. The one-bedroom, two-bedroom, and three-bedroom units are separated into separate segments and shown in Figure 8.2, and the overall market averages are presented in Figure 8.3.

Bedrooms	Sale Price	Price/SF	Total SF
1	$309,000	$534.60	578
1	$349,000	$467.83	746
1	$399,000	$454.44	878
1	$200,000	$563.38	355
1	$225,000	$424.53	530
1	$247,000	$399.68	618
1	$250,500	$470.86	532
1	$289,000	$411.10	703
1	$295,000	$398.11	741
1	$299,000	$425.32	703
1	$309,000	$439.54	703
1	$319,000	$453.77	703
1	$309,000	$439.54	703
1	$309,000	$381.48	810
1	$324,900	$401.11	810
1	$365,000	$431.95	845
1	$219,000	$378.24	579
1	$219,000	$378.24	579
1	$219,000	$378.24	579
1	$197,000	$400.41	492
1	$210,000	$361.45	581
1	$244,000	$293.98	830
1	$399,000	$399.00	1,000
1	$270,000	$355.26	760
1	$320,000	$359.55	890
1	$322,000	$382.88	841
1-Bed Average	**$285,285**	**$410.05**	**696**

Bedrooms	Sale Price	Price/SF	Total SF
3	$529,000	$400.15	1,322
3	$549,000	$406.67	1,350
3	$529,000	$350.56	1,509
3	$499,000	$288.11	1,732
3	$489,000	$305.63	1,600
3	$537,000	$298.33	1,800
3	$499,000	$398.88	1,251
3	$527,000	$398.64	1,322
3	$619,000	$393.02	1,575
3	$445,000	$317.86	1,400
3	$380,000	$351.85	1,080
3	$521,000	$412.51	1,263
3	$466,650	$424.23	1,100
3	$399,000	$399.00	1,000
3	$410,000	$315.38	1,300
3-Bed Average	**$493,243**	**$359.09**	**1,374**

Bedrooms	Sale Price	Price/SF	Total SF
2	$439,000	$377.47	1,163
2	$459,000	$388.65	1,181
2	$499,000	$392.91	1,270
2	$519,000	$360.42	1,440
2	$300,000	$428.57	700
2	$345,900	$425.46	813
2	$349,300	$401.49	870
2	$351,000	$407.67	861
2	$390,000	$428.57	910
2	$358,500	$426.28	841
2	$365,000	$391.63	932
2	$366,000	$393.55	930
2	$379,000	$407.53	930
2	$385,000	$398.96	965
2	$416,000	$392.08	1,061
2	$445,000	$429.54	1,036
2	$475,000	$427.93	1,110
2	$492,000	$439.68	1,119
2	$490,000	$436.72	1,122
2	$510,000	$458.22	1,113
2	$530,000	$486.69	1,089
2	$330,000	$399.52	826
2	$338,518	$404.44	837
2	$259,900	$371.29	700
2	$289,900	$402.64	720
2	$295,000	$409.72	720
2	$389,000	$386.68	1,006
2	$405,000	$368.18	1,100
2	$368,000	$346.84	1,061
2	$349,000	$349.00	1,000
2	$334,000	$345.40	967
2	$355,000	$352.18	1,008
2	$385,000	$320.03	1,203
2	$300,000	$400.00	750
2	$300,000	$395.78	758
2	$310,000	$414.44	748
2	$329,700	$366.33	900
2	$335,000	$406.55	824
2	$360,000	$351.22	1,025
2	$330,000	$352.19	937
2	$349,000	$363.16	961
2	$360,000	$374.61	961
2	$366,000	$369.32	991
2	$373,000	$346.01	1,078
2	$315,000	$388.89	810
2	$407,000	$406.19	1,002
2	$410,000	$421.38	973
2	$415,000	$329.37	1,260
2	$429,000	$335.42	1,279
2	$495,000	$387.32	1,278
2	$385,000	$350.00	1,100
2-Bed Average	**$382,955**	**$388.76**	**985**

Figure 8.2

OVERALL MARKET AVERAGE					
	Sale Price	Price/SF	Upper Limit ($/SF)	Lower Limit ($/SF)	Unit Size
Market Average	**$373,334**	**$393.04**	**$288.11**	**$563.38**	**967**

Figure 8.3

We assigned the average sellout price per square foot as a simulation input. Consistent with comparable sales data, we defined the range for the simulation variable as having a minimum value of $288.11per square foot, and a maximum value of $563.38. The simulation tool then allows the user to select a distribution of possible input variable values between the established upper and lower bounds. Because of the flexibility afforded the user to define a distribution exactly as desired, we elected to use the "Cumulative" distribution. The "Cumulative" distribution permits the analyst to assign specific probabilities of achieving certain interim input values between the minimum and maximum limits. To facilitate description of our process, we used the sellout spectrum data presented in Figure 6.5, defined as the quartile values of sellout price per square foot from the data set, as our interim values. We are then able to assign probabilities to each of the quartiles; specifically, we are able to define the likelihood of achieving an aggregate average sellout price per square foot equal to or lesser than each of the benchmark quartiles.

The benchmark quartile values are entered into an X-table (see Figure 8.5) in the "Cumulative" distribution. In the P-table (Figure 8.5), the analyst must enter the desired probabilistic values associated with each quartile. But how does one assign the probabilistic values? For this, we look to gain insight from the general real estate condominium market in Boston, as presented by the Case Shiller Condominium Index.

Case Shiller Condominium Index

We will utilize the Case Shiller Condominium Index to help inform the probabilistic range of sales price per square foot. This information is displayed in the P-table (Figure 8.5). The Case Shiller Condominium Index for the relevant metropolitan statistical area (MSA) was determined to be the most appropriate proxy for evaluation of the cyclicality of the condominium market. The index tracks aggregate valuations against a benchmark year and month, January 1995, at which time the index value was pegged to 59.81. Figure 8.4 shows a graphical display of the index from inception to the point in time when this development ex ante projection was being made. The index continues to the present time, but we have analyzed the index only to April 2004, as this is the information the developer would have at his proposal to inform his decision-making. We utilized the seasonally adjusted Cash Shiller Condominium Index, and made adjustments for inflation before plotting the data.
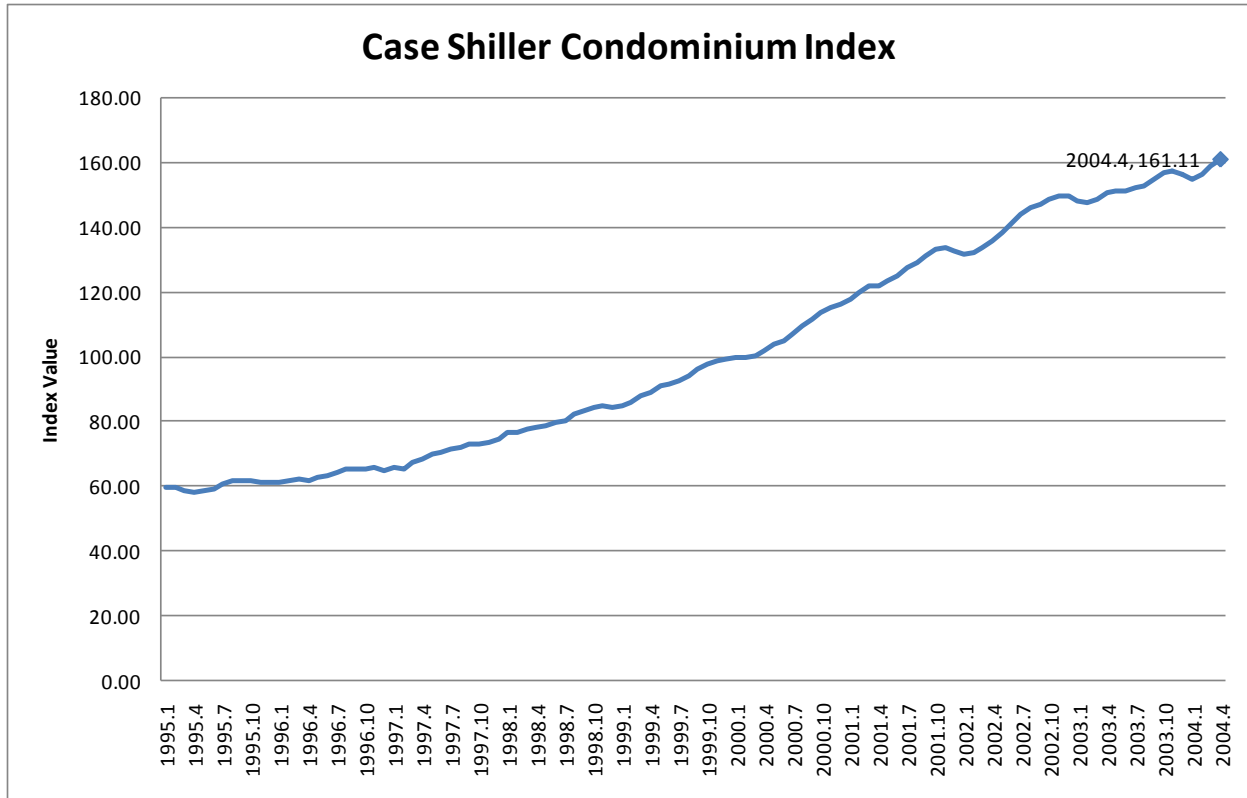
Figure 8.4

From a broad perspective, and without the use of calculus to determine first order derivatives of the function of the depicted curve, we recognize that the index appears to be reaching an inflection point at approximately the same time the developer chose to purchase the original parcel and to execute the deal. When one considers the trough evident at the beginning of the index (1995), it is also consistent with cycle theories that a peak would be expected between 2002 and 2005. At this juncture, for the purpose of shaping input assumption distributions, we logically conclude that based on cyclicality there is a greater chance the market will soften than continue trending upward. While it is difficult to ascertain exactly when the market will undergo correction or to what extent, the inflection point marks a time in the cycle where we conclude that values are more likely to mean revert and trend downward than to continue to ascend.

Consequently, while we recognize the current market and past comparables indicate an average sellout price per square foot of approximately $393.04, the Case Shiller Condominium Index indicates that sellout prices have been increasing for approximately 10 years. If one believes that the real estate market is mean-reverting, the index shows that sales prices for condominiums may soon decline. As a result, we have used estimates for P-values to more heavily weight lesser prices per square foot than the mean of $393.04. We have estimated the following prices per square foot (based on quartile data) and

probabilities (generally informed by the Case Shiller Condominium Index). The X-table and P-tables can be found in Figure 8.5

X-Value	P-Value
$288.11	0.00
$362.73	0.60
$398.37	0.80
$416.17	0.90
$563.38	1.00

Figure 8.5

The P-values indicate the percentage chance that the simulation process will generate an estimate for the average sellout price per square foot that is less than the corresponding X-value. For example, we presume that because the market is likely to stagnate or decline, there is a 100.0% chance that the sellout input will fall short of $563.38 per square foot. Additionally there is a 90.0% chance that the sellout input will fall below $416.17 per square foot. Said differently, there is approximately a 10.0% chance that the average sellout price per square foot will fall within the fourth quartile. As is now clear, we have more heavily weighted the lower end of the sellout price spectrum. As a result, the @Risk (Sale Price per square foot) graphic displays that the assigned "Cumulative" distribution shaped from the X-values and P-values yields a new expected mean sellout price per square foot of approximately $361.07. The approximate 10.0% decline in mean sellout price per square foot ($361.07 versus $393.04) captures the risk of market softening depicted in the index.

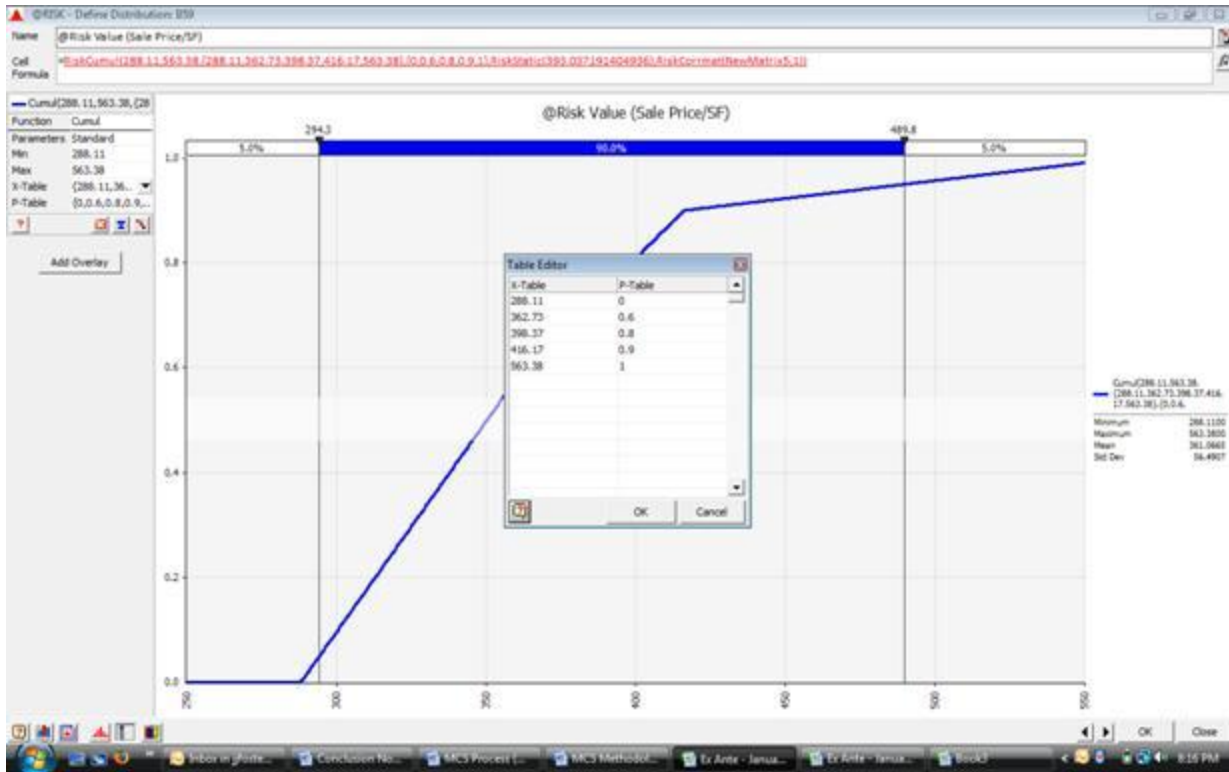**Figure 8.6**

Figure 8.7 shows the probability frontier, or Cumulative distribution created from the aforementioned X and P tables.
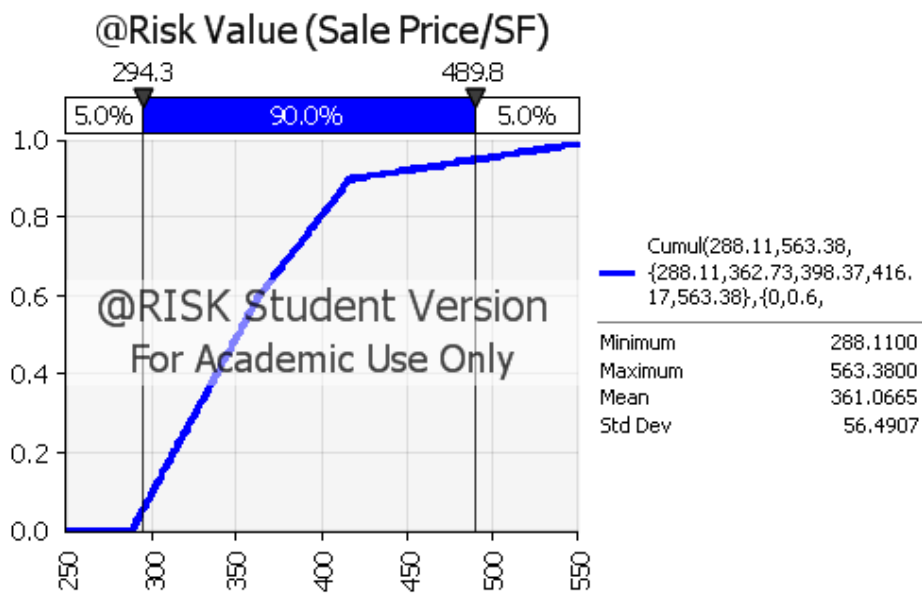

Figure 8.7

The values for both mean and standard deviation of the distribution can also be found in Figure 6.10. It is the specific selection of probabilities at interim benchmarks by the analyst that will dictate how these values change.

Sales Velocity

The second input variable to which we applied a simulation range and distribution is velocity of sales of the condominiums by the market. Consistent with developer sentiment, the pace of sellout can have a profound impact on project returns. In the original ex ante proforma the developer forecast that sellout would occur over three months, to begin one full month following the projected completion of construction in Q1 2006. In the initial month of sales the developer predicted that approximately 57.1% of all constructed units would be sold, and that in each month thereafter, for two months, approximately half of the previous month's sold units would be sold.

The original developer forecast declining sales velocity, with the highest number of units sold the month of completion. This is because marketing was ongoing as construction proceeded. Upon completion of construction and certificate of occupancy, it is logical to assume a larger number of condominium unit sales closed, and then sales velocity gradually declined. In order to maintain consistency with the original developer ex ante proforma, we have also maintained a gradually declining forecast of sold units over the duration of the sellout period, beginning one full month after the projected completion of construction. Based upon qualitative assessment of the Case Shiller Condominium Index and the potential downturn in the market, we believe it was more prudent to stagger the pace of sales over a greater number of months. At this juncture we are able to assign a range and a cumulative probability distribution to sales velocity and execute the simulation.

By use of a multiplier ranging from 0 to1 that represents sales velocity (0 representing slow sales velocity and 1 representing fast velocity), we establish a range that allows for velocity to vary between four months and 15 months. We have established X and P tables, shown in Figure 8.8, to form our probability distribution.

X-Value	P-Value
0.20	0.20
0.40	0.40
0.60	0.60
0.80	0.80
1.00	1.00

Figure 8.8

We presume that there is a 100.0% chance that the multiplier input will fall short of 1.0, which had translated to a total sellout period of 4 months. There is an 80.0% chance that the multiplier input will fall below 0.8, there is a 20.0% chance that the multiplier will equal 0.2, translating to a sellout over 15 months, and so on. The prescribed cumulative distribution results in a mean multiplier value of 0.52.
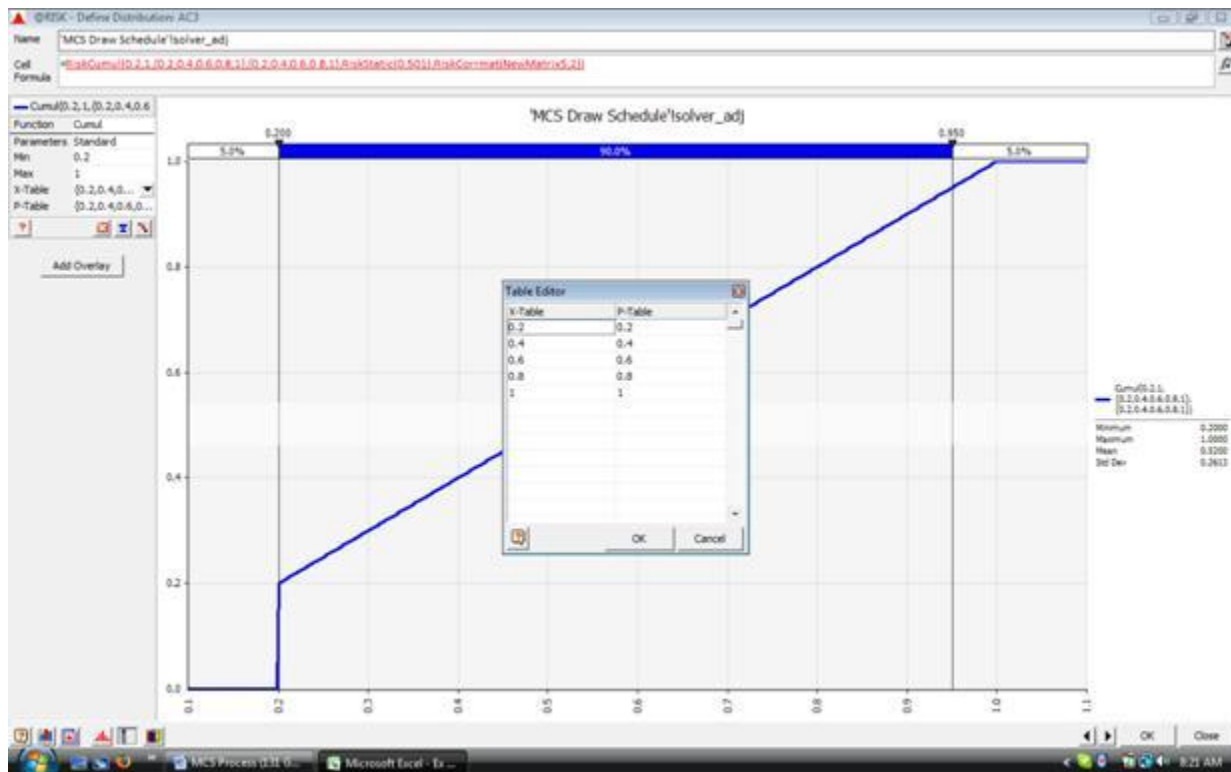

Figure 8.9

Figure 8.10 shows the probability frontier, or Culumative distribution created from the aforementioned X and P tables.
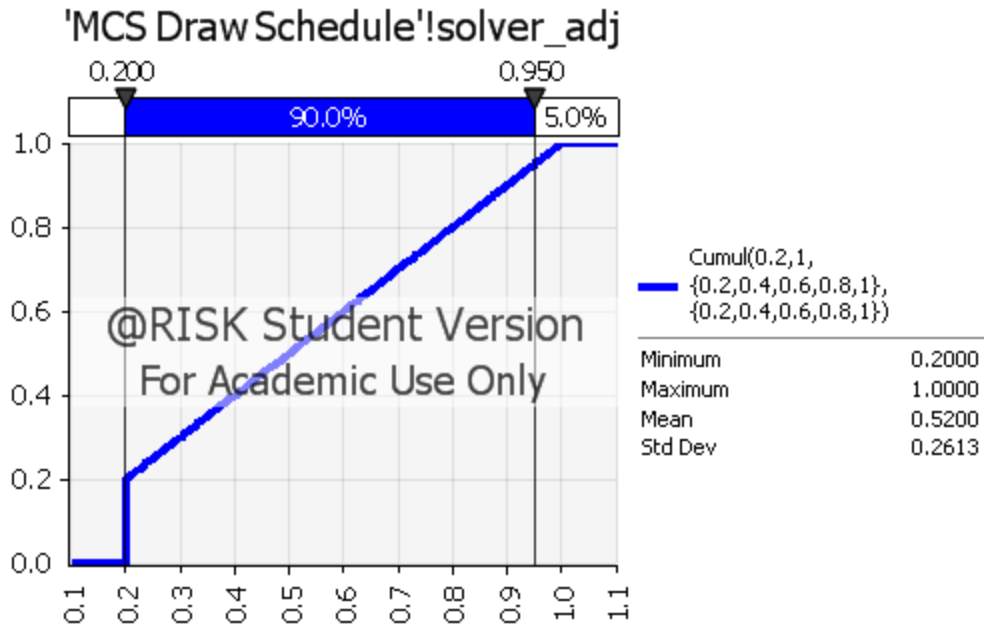
Figure 8.10

8.3 Variable Correlation

A final consideration for the simulation run concerns correlation between the selected input variables. A correlation coefficient between -1.0 and 1.0 can be used to assign a level of positive or negative linear dependence between the two selected input variables.

For purposes of our simulation exercise we must assign a correlation coefficient between the average condominium sellout price per square foot and the velocity of sales following construction. One could logically conclude that in a softening condominium market, again as assumed based on the movement of the Case Shiller Condominium Index, that it is likely that in order to counteract slowing velocity, the developer would drop asking prices for unsold condominiums. Thus, for purposes of the simulation, when average sellout prices decline then the velocity multiplier will increase, accelerating sellout; we recognize this as a negative linear relationship between the variables. To ensure that MCS precludes situations where average pricing increases and velocity also increases, or when prices decrease and pace of sellout slows we use a negative correlation coefficient between the input variables of -0.5.

8.4 Simulation Execution

At this time we are able to run the simulation. The output variable has been assigned as the equity unlevered IRR, and the input variables have been selected and governed as well. Once the distribution attributes have been selected and the correlation coefficient between the two variables has been assigned, the analyst can specify simulation settings. Among the more basic simulation settings are number of simulations desired, number of iterations (scenarios), and graphical outputs generated upon completion of the simulation(s). We perceive that for purposes of this simulation exercise 1,000 iterations is sufficient to appropriately reflect randomness in the input assumption estimates. After these simulation settings have been confirmed, the user can run the simulation.

Upon completion of all iterations in the simulation(s) the @Risk add-in will provide both input and output summaries. The summaries include graphical displays of all of the values generated for each input and the assigned output. These histograms plot the density of the data, displaying tabulated frequencies as bars. The frequencies are reflective of the cumulative distributions assigned prior to simulation, and are demonstrative of our interpretations of the Case Shiller Condominium Index, and the comparable sales data provided by brokers. These input and output summaries are assessed in Chapter 8.5, as follows.

8.5 Monte Carlo Simulation Results

Input Variables

The simulation exercise described in the Deal-Specific methodology segment of the thesis yielded a variety of graphical and tabular displays of simulation results. The results must be dissected quantitatively and qualitatively to best understand the simulation. Additionally, it is crucial to consider the process associated with assigning output variable, input variables, and all distributional attributes when contemplating the use of MCS as a complement to DCF. We'll begin by assessing each of the input distributions resulting from the 1,000 scenarios generated during the simulation.
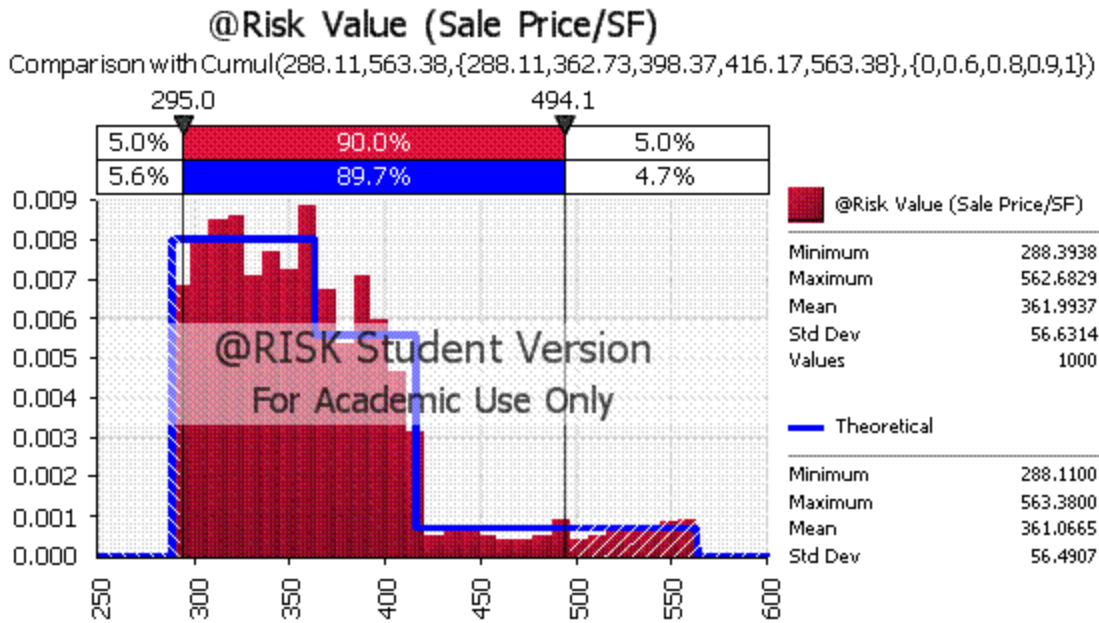
Figure 8.11

Figure 8.11 is a graphical display of the average sellout price per square foot generated during the 1,000 iterations of the simulation. The minimum and maximum limits were established based on comparable data. The 90.0% confidence interval for the input variable ranged from 295.0 to 494.1, indicating that 90.0% of all iterations in the simulation yielded an estimate for the variable between these two values. The histogram, comprised of the varying vertical bars, represents all of the values generated during the simulation. The nested "Theoretical" line indicates those values that exactly adhere to the cumulative distribution formed in the X-Table & P-Table. It is important to recognize that although the comparable data provided by brokers – upon which upper bounds, lower bounds, and quartiles were based – helped define a relevant range for the data, the assigned distribution shape is largely subjective.
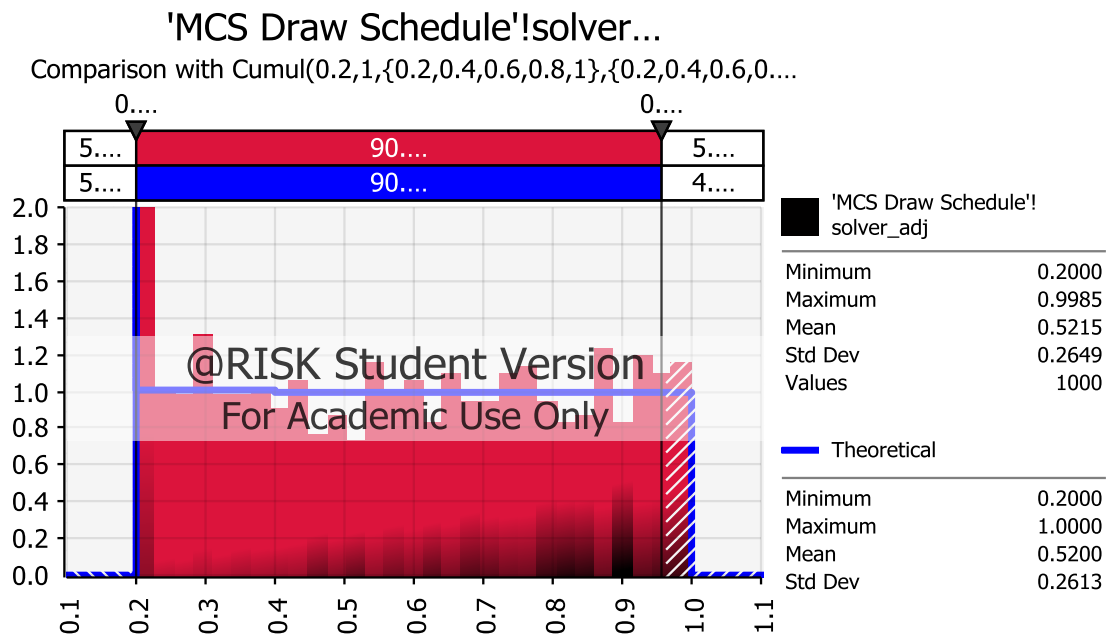
Figure 8.12

The graphical display of velocity multiplier values is shown in Figure 8.12. This particular input variable was defined by the authors based upon qualitative interpretation of the Case Shiller Condominium Index. Both first-month sales as well as subsequent velocity were depressed by the authors based upon the determination that cycle timing suggested a downturn in the market was forthcoming. First month sales were reduced to approximately 28.56% of overall units, down from the ex ante proforma projection of approximately 57.14%. As detailed earlier, velocity was defined as ranging between four months and 15 months, with a heavier weighting applied to the multiplier value corresponding to longer duration sellout. Resultantly, the average multiplier value of 0.5215 results in an average expected sellout period of 7 months compared with the original DCF ex ante proforma estimate of approximately 3 months. The 90.0% confidence interval for the variable ranged from a low of 0.2 to a high of 0.956.

We also recognize that the two input variables we selected for simulation testing were both revenue drivers. The variables were selected because of their respective impact to the selected output variable however any or all of a number of cost inputs could also have been tested in similar fashion by defining range, distribution, and correlation coefficient(s). We perceived these variables to be most impactful to the return generated for the transaction, and elected to simplify the analysis by limiting the number and type of variables tested. A more comprehensive simulation exercise using other proforma variables can also be performed.

Correlation Coefficient

The correlation coefficient represents another input assumption made based upon a general assessment of how the two selected input variables co-move. There exist a variety of methods for calculating a correlation coefficient, the most common of which require many data points over a long time series in order to be considered statistically significant. In the absence of such data, there are also a number of non-parametric tests that can be used to generate a correlation coefficient between variables. We chose to assign the correlation coefficient in a qualitative manner in order to simplify the MCS process as a complement to traditional DCF. A great deal of rigorous statistical analysis is otherwise required to estimate correlations, and that analysis cannot provide meaningful conclusions to the correlations without a larger sample size.

Output Variable

After performing the simulation, summary data is provided for the output variable. The output range and distribution are derived from the range of assumptions and distributions of the selected input variables. Ranges and cumulative distributions used for both sellout pricing and velocity result in a probabilistic distribution of expected unlevered IRR. The graphical and tabular return data is summarized in Figure 8.13, and is interpreted thereafter:

@RISK Output Report for Equity IRR Unlevered

Performed By: Jason
Date: Monday, July 06, 2009 3:37:51 PM

Simulation Summary Information	
Workbook Name	Ex Ante - January 18, 2005 MCS.xlsx
Number of Simulations	1
Number of Iterations	1000
Number of Inputs	2
Number of Outputs	1
Sampling Type	Monte Carlo
Simulation Start Time	7/6/09 15:31:02
Simulation Duration	00:01:29
Random # Generator	Mersenne Twister
Random Seed	154577474

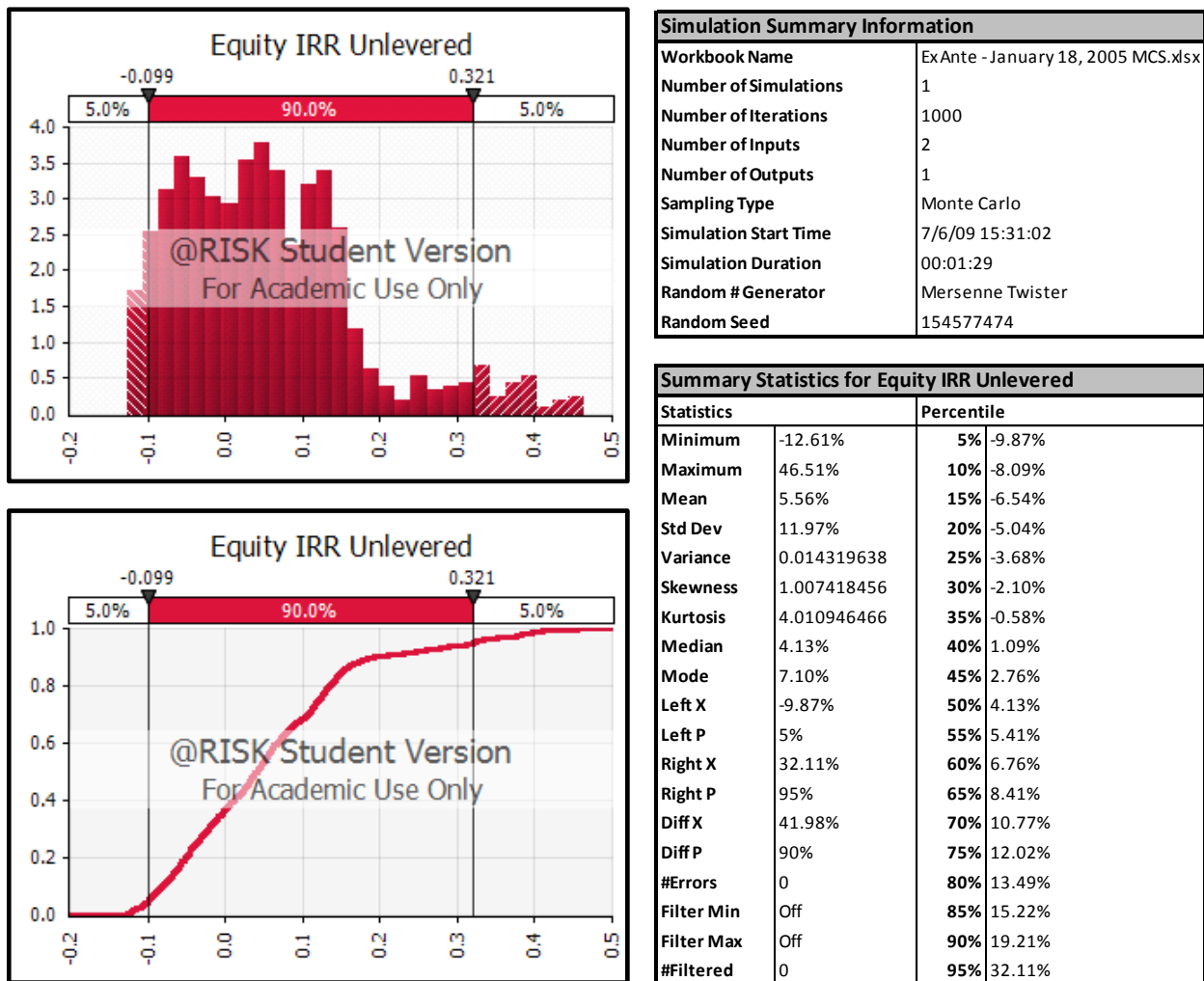| Summary Statistics for Equity IRR Unlevered			
Statistics		Percentile	
Minimum	-12.61%	5%	-9.87%
Maximum	46.51%	10%	-8.09%
Mean	5.56%	15%	-6.54%
Std Dev	11.97%	20%	-5.04%
Variance	0.014319638	25%	-3.68%
Skewness	1.007418456	30%	-2.10%
Kurtosis	4.010946466	35%	-0.58%
Median	4.13%	40%	1.09%
Mode	7.10%	45%	2.76%
Left X	-9.87%	50%	4.13%
Left P	5%	55%	5.41%
Right X	32.11%	60%	6.76%
Right P	95%	65%	8.41%
Diff X	41.98%	70%	10.77%
Diff P	90%	75%	12.02%
#Errors	0	80%	13.49%
Filter Min	Off	85%	15.22%
Filter Max	Off	90%	19.21%
#Filtered	0	95%	32.11%

Figure 8.13

@Risk Output Variable Result Tabulation

Key Summary Statistics

The simulation exercise yields a variety of output statistics which provide the user with important information regarding the uncertainty of the transaction returns. We'll now call attention to some specific information from which the developer can draw qualitative conclusions about the project.

As shown in Figure 8.13, the minimum and maximum expected returns generated after 1,000 iterations are -12.61% and 46.51%, respectively. More importantly, the 90.0% confidence interval for the project is -9.87% and 32.11%. We interpret this statistic to indicate that of all the iterations run, 90.0% of the time

the IRR returned by the model fell between these two limits. Such a wide discrepancy, further denoted by the standard deviation of returns of 11.97%, suggests that given the current model and the specific tested inputs we are unable to provide a narrow range for expected returns. Such return volatility is indicative of the risk associated with the project, and with the significant uncertainty surrounding transaction returns.

Despite the wide range of expected transaction returns, many of which were negative (approximately 35.0%-40.0%), the average or mean expected return was 5.56%. The midpoint of all return data (median) was 4.13% and the most frequently generated return (mode) was 7.10%. These values are clearly all positive, and are clustered about an equity unlevered IRR value of approximately 5.0%. The histogram in Figure 8.13 reflects both the wide range of possible returns, as well as the 90.0% confidence interval. We can see that the distribution of returns is skewed right, with higher frequency of returns tabulated on the left side of the graph. We could expect such a distribution based on our assignment of P-values in each of the input P-tables, which provided a mechanism for us to reflect market softening in our projections of likely input variable values (based on the perceived inflection point in the Case Shiller Condominium Index). All transaction returns are shown next to the associated percentiles on the right side of the "Summary Statistics for Equity IRR Unlevered" table.

Consistent with developer protocol, for this simulation we'll focus on the interpretation of the maximum, minimum, and mean generated return values. The maximum return limit suggests that if everything goes better than originally expected, where average sellout prices per square foot exceed expectations and are somewhere near the prescribed maximum possible price of $563.68 per square foot, and velocity increases such that complete sellout occurs in approximately 4.0 months (multiplier value of nearly 1.0), the best possible outcome is a return of 46.51%. This value, however, is considered in common statistical analysis as an outlier. Because it falls outside of the 90.0% confidence interval, we recognize that this value is unlikely, occurring more than 1.6 standard deviations above the mean expected return.

The minimum return generated should be thought of in much the same way. A return of -12.61% is possible, based on the simulation exercise, but is unlikely to occur as it is 1.6 standard deviations below the mean expected return. In order for this pessimistic scenario to occur, velocity would have to fall to where sellout of all construction units occurs in approximately 15.0 months, and at prices near the minimum assigned range ($288.39).

Given the ranges used of the selected inputs, we would expect that the base case scenario would likely offer a return around the mean of 5.56%. Stated differently, given the ranges and applied distributions of the input variables, we would expect under normal circumstances to receive an equity unlevered IRR of 5.56%. More generically, when we consider what is often expected by developers for comparable

opportunistic development transactions, it is not 5.56%. Instead, developers often offer returns to their respective capital sources that reach or exceed 15.0%. In the ex ante/ex post component of the thesis we witness that the average ex ante proforma IRR across the eight transactions was actually 23.2%. The base case scenario often is depicted to generate such a desired return. Moreover, the typical pessimistic scenario may generate a slightly less return, and the typical optimistic scenario may generate a return that exceeds the base case return. Seldom, however, does a developer generate a pessimistic scenario that yields a negative IRR. Additionally, a developer would never propose to undertake a deal where fully 35.0%-40.0% of all possible returns are expected (based on statistics) to be less than or equal to 0.0%.

This suggests that while developers fully acknowledge that an optimistic scenario can generate exceptional returns, exceeding the expectations of investors, the downside uncertainty of possible returns is likely under-represented. At a fundamental level, the results of the simulation exercise illuminate the possible and likely returns, and may provide the developer more thorough information upon which to base the decision to move forward with or abandon the targeted project. We can also use the simulation results to ascertain the likelihood of the developer providing investors with the typical promised "base case" return of approximately 15.0%. By assessing the percentiles shown on the "Summary Statistics" table, we can see that an equity unlevered IRR corresponds to, approximately, the 85th percentile. We interpret this information to mean that based upon the simulation there exists only a 15.0% +/- chance that the return will meet or exceed the desired return. Also, the likelihood of strong returns decreases dramatically as the return increases above 15.0%. As an investor or a developer, this information is of exceptional importance. Considering the equity capital employed in the transaction, and the substantial risk assumed when undertaking a real estate development deal, the limited opportunity for returns that exceed the targeted 15.0% may be concerning to all involved parties.

Also of concern to involved parties is the standard deviation of expected equity unlevered IRR. With a standard deviation of 11.97% there is a great deal of volatility to the returns. In fairness, such a broad range of possible IRR across all percentiles is merely exemplary of the tremendous risk associated with the investment. However, such a comprehensive picture of possible returns is rarely painted by developers for investors. An articulation of all expected returns and of the variability in those returns is important for investors to understand as it may inform their respective investment decisions. Perhaps there are alternative real estate investment opportunities available that offer a more narrowed range of possible outcomes? Perhaps investment in another asset class altogether can provide positive opportunistic returns with more limited downside risk? These questions are all of paramount importance to participants in a real estate development transaction, and it is conceivable that simulation may help address some or all of them.

8.6 Simulation Conclusion

The simulation component of the thesis was undertaken in an effort to understand how and to what extent the process of scenario generation might complement traditional DCF as a method for valuing a vanilla development transaction. After using the MCS to perform a comprehensive scenario analysis we are able to draw a variety of conclusions.

We begin by concluding that MCS allows analysts to determine the spectrum of likely critical information may dramatically affect the decisions made surrounding the development, including the decision of whether to execute the transaction. In the context of risk and reward, the developer and investors are able to better understand the expected overall exposure and the potential for returns in excess of normative returns. The sensitivity analysis provided by the Monte Carlo Simulation tool can be of use to transaction participants, and provides a more rigorous quantitative framework in which to assess the merits of a project. However the challenges associated with building simulation assumption inputs are noteworthy, and lead us to our second conclusion.

We recognize that while our selection of the Case Shiller Condominium Index appears to be the most comprehensive index kept for all for-sale residential condominiums in the deal submarket, there may exist other data sets or indices that provide a better proxy for condominium values. No econometric analysis or other rigorous quantitative analysis was performed to isolate the index. Also, determination of location within the cycle was a purely qualitative assessment based on general recognition of the residential real estate cycle length, and on the appearance of downward trending on the graph. We acknowledge that these qualitative determinations represent the opinions of the authors, and are not supported through proven scientific method.

The complexity associated with selection of ranges and distributions is exceptional. The ability to assign the appropriate range for an input variable presupposes that the developer has access to a plethora of market information and comparable transaction data. Without an understanding of what transactions have occurred in the relevant submarket in the recent past the developer is unable to benchmark limits or interim milestone values (quartiles, etc.). The inability to accurately determine a finite and narrow range will lead to a correspondingly wide range of possible output values. The wider output range yields both a greater standard deviation of returns and only reflects increasing uncertainty of returns.

It is also important to recognize that not all comparable transactions are created equal. Many development transactions are entirely unique to a submarket and may not have a current or local direct comparable. When relevant comparables are available, it can be relatively certain that the two products are dissimilar

in more than a few ways. They occupy different spaces, experience different market effects, and interact with their surroundings in different ways. To be fair, a building built to the identical spec as a sister building, located immediately next door, is a comparable transaction but is by no means identical. The unique nature of the real estate development transaction requires that all parties involved on each side of the transaction recognize the inherent strengths and weaknesses of each property compared to other similar properties. As such, defining ranges for variables based exclusively on data from comparable transactions is naturally an inexact art, and not entirely scientific or quantifiable.

The selection of a distribution to define the possible movement of an input variable as it is affected by endogenous variables is also more art than science. For those who believe in the efficient market hypothesis (EMH), the normal distribution is the appropriate distribution against which to consider fluctuations in variables. However real estate does not follow all of the same patterns as the equity and fixed income markets for which the EMH is more applicable. As a result, which of the many distribution options is best suited to explain each input variable? Without substantial market data, it is virtually impossible to assign a distribution that will serve to explain all of the possible movements of a given variable. Real estate, as an asset class, has only been closely tracked for the past 25-30 years. Further, many real estate indices and data sets are inexact and incomprehensive. Transactions are often opaque, transaction volume is limited, and the underlying product – the property, itself – is unique. Without commoditized product, as with equities and fixed income securities, we are unable to assume that what serves as rule for one transaction is rule for any other.

Associated with the challenge of assigning a distribution is the assignment of correlation coefficients between all selected input variables. Again, without a substantial amount of reliable data, we are unable to accurately determine the appropriate measure of co-movement between variables. Worse, there exist an unlimited number of factors that can exact immeasurable change on one or more variables. Without an ability to determine, with minimal or no exception, how variables move with one another we are unable to assign a true measure of correlation. The same simulation performed with a correlation coefficient of -1.0, 0.5, or 1.0 rather than the prescribed -0.5 would result in a different return distribution. Output variable results of simulations performed at each of the above correlation coefficients are depicted below. Variability in returns would have been more pronounced when correlation coefficients were modified had expenses and revenues been used as variables as opposed to strictly revenue-related variables.
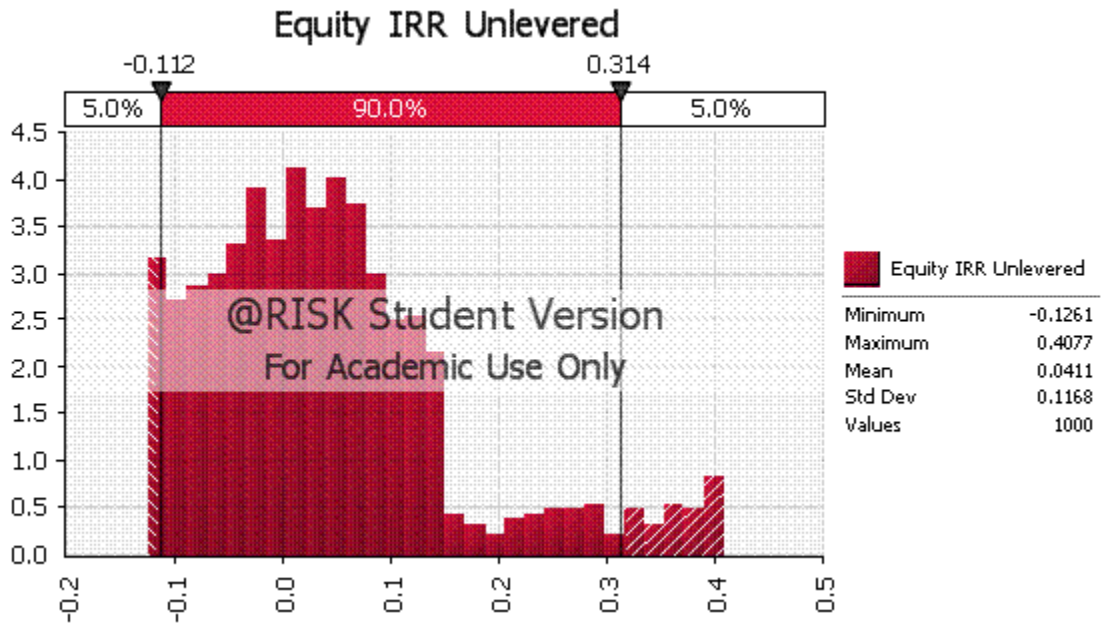
Correlation Coefficient = -1.0
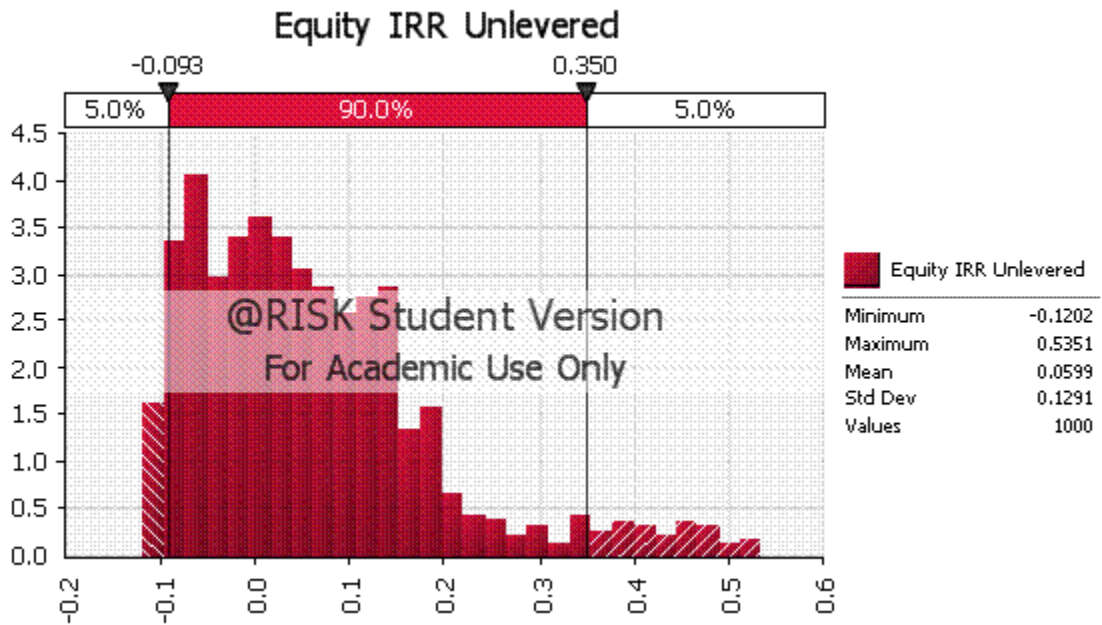

Figure 8.14

Correlation Coefficient = 0.5

Figure 8.15

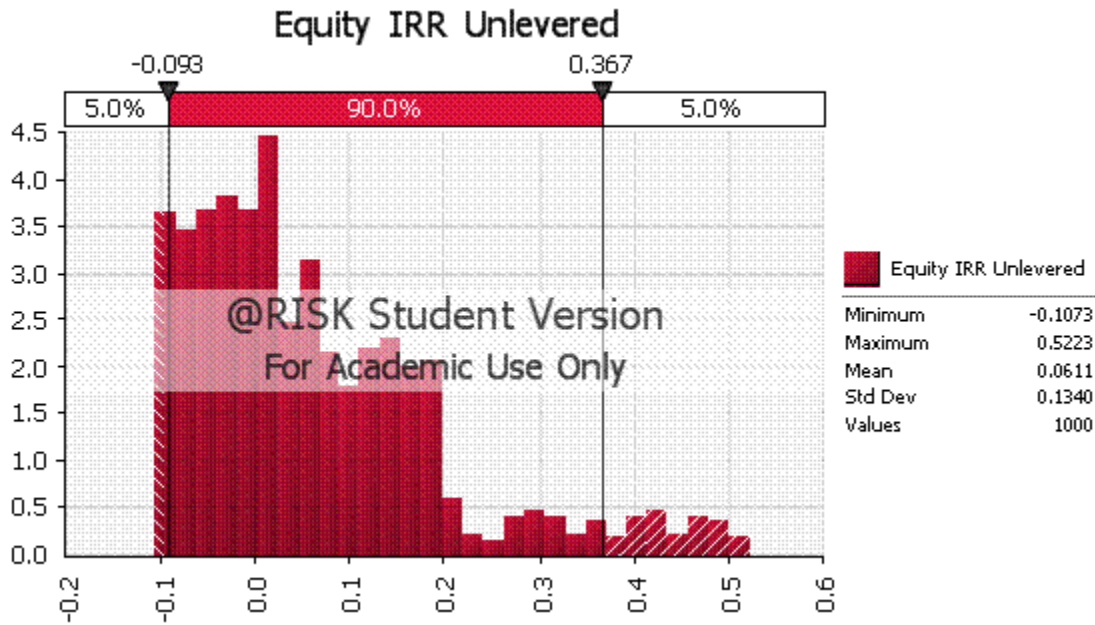**Correlation Coefficient = 1.0**

Figure 8.16

Differences in maximum and minimum limits, as well as in average returns and standard deviation of returns underscores the importance of appropriately assessing the co-movement between variables.

(Mean) Expected Return	
Ex Ante	15.78%
Ex Ante (MCS)	5.56%
Ex Post	-1.57%

Aggregate Discrepancy	
Ex Ante / Ex Post	17.35%
Ex Ante / Ex Ante (MCS)	10.22%
Ex Ante (MCS) / Ex Post	7.13%

Figure 8.17

Figures 8.14 through 8.17 indicate the overall improvement to equity unlevered IRR forecast using MCS for the selected deal. We witness that, in absolute terms, the ex ante proforma return differed from the ex post proforma return by approximately 17.35%. The ex ante MCS proforma, however, differed from the ex post proforma by only 7.13%. While it is apparent that the margin of error remains high despite the use

of simulation, one can immediately begin to understand how the simulation tool could become a useful complement to traditional DCF analysis. In spite of all of the issues surrounding simulation inputs, including variable range and correlation coefficient, the tool performed as we had hoped, helping to mitigate some of the discrepancy arising between the ex ante and ex post proforma returns.

Provided all of the challenges associated with Monte Carlo Simulation execution, we also conclude that the tool is currently too sophisticated to be a useful complement to traditional DCF valuation analysis. The data requirements for range, distribution, and correlation coefficient assignment are significant. From a practical perspective, in addition to making point estimates for range limits, the simulator also requires that the analyst make auxiliary input assumptions. These assumptions, because they are so heavily reliant on detailed historical data, are often more unfounded than the initial point estimate assumptions made in the original ex ante proforma. Perhaps the reason there are no published papers or textbooks about the use of simulation in real estate valuation purposes is directly attributable to the complexity of a statistically significant simulation analysis. We do, however, believe that the real estate industry will make great use of the tool in the years to come. As databases continue to grow, and as developers and investors become more experienced and sophisticated, we anticipate that the use of simulation as a sensitivity analysis tool will become more commonplace. The intrinsic value of the tool itself lies in the ability of the user to make informed assumptions about the underlying statistics.

The ability for a developer to articulate and quantify uncertainty of returns will become increasingly important to the selection of the real estate asset class in portfolio allocations. Additionally, it can give perspective on the risk-return relationship in real estate for both development transactions and stabilized product. A comprehensive and sophisticated analysis that yields information on returns and return volatility could have significant impact on real estate investment theory. Clearly there are instances where traditional DCF has performed well, and where it has underperformed as a valuation tool. A sophisticated brand of DCF that captures market analytics in shaping variables may very well be the future of real estate valuation practice, however it remains to be seen if the unique nature of property will ultimately prevent developers from guessing smarter.

8.7 Suggestions for Further Research

The authors hope this thesis has provided meaningful information regarding ex ante and ex post real estate development returns and the potential to use Monte Carlo Simulation during the development return projection process.

We recognize that what is most important to the study of development returns is additional, comprehensive development transaction data. During our research we became familiar with the Korpacz

Real Estate Investor Survey, which tracks ex ante internal rates of return for stabilized institutional real estate. We are confident that in time this type and quality of survey could be replicated to track real estate development returns, as well. Additional research comparing ex ante and ex post development returns may provide developers with an improved ability to project ex post returns, perhaps mitigating return volatility. Further study may also provide investors with more detailed information when contemplating the risk and return for real estate development compared to other investment opportunities.

The thesis data set was limited to eight case studies, which was primarily due to time constraints. While we feel that the data are a representative sample of the overall industry from 1999 to 2008, and that our findings make intuitive sense, we acknowledge that a larger data set is required for the study in order to draw statistically significant conclusions. A broad data set, consisting of hundreds of development ex ante and ex post proformas, may provide more meaningful results. The ideal data set would contain projects throughout the United States and would span multiple market cycles. Using data that span multiple cycles may enable researchers to better understand and predict overall market trend duration and magnitude.

Finally, during the course of our study we found many interesting auxiliary research topics pertaining to the opportunity for the application of Monte Carlo Simulation in the real estate development industry. In regards to simulation, the most important unanswered questions surround the correlation of proforma input variables. Again, the data required to generate accurate estimates for correlation coefficients may be prohibitive. Thought we acknowledge that no development transaction is exactly like another, and that there is limited historical data with which to analyze variable correlations, more rigorous exploration of the topic is possible.

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