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REAL ESTATE MATHEMATICS

Applied analytics and quantitative methods for private real estate investing

Edited by
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About the editors

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Dr. David Lynn is an institutional real estate investor, strategist and portfolio manager with 25 years of experience in national and international markets. At Clarion Partners (formerly ING Real Estate Investment Management), he is managing director and partner. He guides the firm's strategic and tactical investment decisions across funds, portfolios and separate accounts for $22 billion in assets under management. He is a member of the Investment Committee and the Operating Committee. He has an extensive and deep network of global real estate business and government relationships.

David has directed the investment and management of billions of dollars of institutional real estate in national and international markets in holding senior executive management positions at AIG Global Real Estate, AvalonBay Communities, the Keppel Corporation (one of the largest property groups in South East Asia headquartered in Singapore), and the Target Corporation (Property Development Group).

David has been published, interviewed and written about in numerous national and international finance and business periodicals. His theoretical work on financial distress developed a new analytical framework for analysing macroeconomic distress factors. His recent book on emerging market real estate investments has been critically acclaimed. He has written several books, including *Active Private Equity Real Estate Strategy* (John Wiley & Sons, 2009) and *Emerging Market Real Estate Investment* (John Wiley & Sons, 2010). He writes a widely read 'Capital Trends' column in the *National Real Estate Investor*. He accurately predicted the dramatic decline of real estate fundamentals and values before the downturn as well as the timing and magnitude of the current recovery.

David earned his PhD in Financial Economics at the London School of Economics, where he also earned a MS in Finance. He earned an MBA from the Sloan School of Management at the Massachusetts Institute of Technology. He earned a MRP in City and Regional Planning with an emphasis in Real Estate from Cornell University. He earned a BA from the University of California at Berkeley. David is actively involved in the industry's major professional organisations, including the Pension Real Estate Association, Urban Land Institute, Homer Hoyt Institute, Counselors of Real Estate and International Council of Shopping Centres.

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Dr. Tim Wang is a senior vice president and senior investment strategist at Clarion Partners (formerly ING Real Estate Investment Management). He joined the firm in 2006, and assists in managing $22 billion in private equity real estate investment. He is responsible for macroeconomic analysis, portfolio strategies, quantitative forecasting and client advisory. Tim has published numerous research articles in real estate journals, including *Real Estate Issues*, *Urban Land*, *Institute for Fiduciary Education* and *The Institutional Real Estate Letter*, and co-authored four real estate strategy books, including *Active Private Equity Real Estate Strategy* (John Wiley & Sons, 2009) and *Emerging Market Real Estate Investment* (John Wiley & Sons,

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Tim is a member of the National Council of Real Estate Investment Fiduciaries, Pension Real Estate Association and Urban Land Institute. He is a frequent guest speaker at real estate investment conferences in the US, and has been quoted in publications including *New York Times*, *Commercial Property Executive*, *Indianapolis Business Journal* and *CoStar Newsletter*. He holds an MBA from the Stern School of Business at New York University and a PhD from the University of Georgia. □

Introduction and acknowledgements

By David Lynn, Clarion Partners

In the aftermath of the 2008 real estate crash, real estate investment professionals were forced to re-evaluate long-standing approaches to investment practices. Once the worst of the crisis had passed, investors and managers were left with the task of carefully reappraising risks and revisiting performance expectations of real estate in order to rebuild investment portfolios.

Real Estate Mathematics seeks to examine the more mathematical and analytical aspects of current trends in real estate investment. Some questions we pose are: What are the mathematical equations behind successful real estate investment? How can these functions be applied to such a diverse asset class as real estate, and what are the most applicable tools for adequately measuring returns in this current climate?

It is the intent of this book, then, to offer explanations to those inquiries, as well as others. *Real Estate Mathematics* addresses the issues that come with a quantitatively-driven market. Among these issues, we thought it would be most beneficial to focus on two of these: the effects of an increase in value-based investing, and the associative variations between real estate equities and real estate debt.

This content is most useful to those investors whose primary focus is on real estate investment, acquisitions and portfolio management.

The contributing authors in the following pages are some of the foremost experts on real estate investment, fund and portfolio management, whose opinions are sought after for their accuracy, consistency and insightful analysis. It has been a great pleasure to collaborate with them in producing this book, and we hope their expertise displayed here proves valuable to your investment goals.

We have classified chapters under one of three main sections:

I. Fundamentals
II. Investing
III. Fund and portfolio management

The chapters discuss many principles of real estate mathematics, including appraisal practices and issues, environmental issues, forecasting real estate due diligence, risk analysis, portfolio management strategies international real estate, distressed debt, debt structuring, real estate cycles and allocations, among others. The chapters are summarised below.

Section I: Fundamentals

Chapter 1: Real estate allocations in multi-asset investment portfolios
We begin this book with an overview of the role of real estate in diversified asset investment portfolios. The benefits of real estate investment are enticing more and more investors, and this chapter focuses on examining those benefits in greater detail. As Greg MacKinnon

explains, careful consideration should be given to relying on assumed benefits of real estate investment – the concepts of inflationary lags, appraisal smoothing and leverage risks are expanded on, as well as other potential issues in real estate investment returns.

Chapter 2: Forecasting real estate returns
Timothy Bellman takes a look at the importance of forecasting in real estate returns, highlighting the differences between retrospective and predictive investment practices. Included is an explanation of the techniques that best determine asset performance, based on both qualitative and quantitative aspects of the market. Bellman argues that forecasting acts on forward potential that exists in the market, rather than a merely reactive practice based on previous data. The needs of the forecaster often dictate which approach is most appropriate – as such, one whose emphasis is on income return may be better served with a more reflective, quantitative analysis, whereas a forecast for capital return will require a greater understanding of the anticipated change in the net operating income. As the amount and quality of data available to analysts continues to expand exponentially, forecasting is likely to adapt to a more predictive practice for investors moving forward.

Chapter 3: Real estate investment capital structure
The following chapter introduces the concept of capital structuring and its reliance on debt financing. According to Hugh Kelly, debt financing can be an appropriate means of maximising value to a variety of investor types, so long as default risks are adequately hedged. Taking an in-depth look at the mathematics behind solid capital structuring, the author makes the case for hybrid capital structuring, utilising both debt and equity financing.

Chapter 4: Contrasting approaches to quantifying risk in real estate investments
Jon Southard examines how to quantify risk in real estate investments, comparing three approaches. Scenario analysis, forward-looking distribution and Monte Carlo simulation (which is discussed at greater length in Chapter 5) can offer different perspectives where an investor can gain a better understanding of the level of hazard associated with a given real estate asset. This chapter seeks to give the reader a better understanding of each approach, and its respective advantages and disadvantages, as they can be applied to individual properties.

Chapter 5: Modelling uncertainty: Monte Carlo analysis and the pricing of real estate
This chapter examines the use of Monte Carlo methods in determining risk. It begins with a review of the basics of Monte Carlo modelling in comparison with other techniques. Authors Randall Zisler and Matthew Zisler make the case for Monte Carlo modelling, even suggesting that more widely used techniques, such as deterministic modelling, are typically inadequate and can no longer accurately portray today's investment scenario. The authors offer a complex analysis of Monte Carlo applications that presents answers for the skilled investor.

Chapter 6: Analysing and pricing risk in international real estate markets
Maurizio Grilli and Richard Barkham focus on the increased activity in international real estate investment since the early 2000s. This interest in overseas markets has sustained, despite inconsistencies in international policies and monetary dependability. However, despite over-exaggerated results in some international markets, the desire for a more globalised portfolio continues to expand. The authors propose a new framework for evaluating risk in investing internationally, taking into account respective hurdle rates and individual countries' potential risks, of which national diversification, corporate presence and independent financial institutions play a large role.

Chapter 7: Special considerations in sustainable property financial analysis
This chapter contains a thorough account of sustainable property investment. Moving beyond the limited results achieved through simple pay-back or simple return on investment, Scott Muldavin presents a six-step process by which analysts can refine the qualitative nature of their research and produce results that consider the effects of sustainability.

Chapter 8: Real estate loans and real estate debt
The relationship between mortgage lending and commercial real estate financing has become increasingly prevalent since 2000. However, with this interdependence comes a new collection of issues. In this chapter, Sam Chandan examines several of these issues in greater depth, offering an analysis of the use of debt in commercial properties and providing standardised equations that can be adjusted to the qualities of specific loans.

Chapter 9: Distressed debt investing
David Lynn and Tim Wang discuss the characteristics of distressed debt, as well as its role in current investment practices. Offering investment strategies that capitalise on the increasing amounts of distressed debt on banks' balance sheets, this chapter illustrates both loan-to-own and hold-to-maturity purchasing, as well as approaches for distressed debt investments.

Section II: Investing

Chapter 10: CMBS securitisation and investing
Understanding commercial mortgage-backed securities as both a lender and asset class is an important tool for participants on either side of the debt-equity line. While differences between pre-crisis and recent CMBS issuance is still under scrutiny, a familiarity with CMBS as both a source of financing as well as a financial asset could be the competitive edge for investors in the near future. This chapter focuses on the intricacies of securitisation, with an emphasis on conduit transactions and the associated risks. Josh Younger traces the oscillation of the CMBS market, from its rise in the 1990s, to its dramatic fall at the onset of the US credit bubble in 2004–2007 through its careful return in present-day investing.

Chapter 11: Key considerations in joint-venture projects
This chapter considers the fundamental differences between the various types of joint-venture projects – specifically, single asset, multi-asset and programmatic joint ventures. With a focus on the cash flow issues associated with joint ventures, authors Roy Schneiderman and Dean Altshuler begin with a simple incentive fee structure and build on it with examples of more complex joint-venture configurations.

Chapter 12: Cash-flow considerations for value-added deals
Pip White and Nigel Allsopp introduce the considerations needed for value-added deals. By restructuring a property through repositioning, investors can increase the value of the investment by enhancing its marketability. This section looks at the delicate balance that must be struck between income needs and capital expenditure needs, and how the correct combination of income return and capital growth (accounting for unexpected costs that may arise over the course of an investment) can solidify a gain.

Chapter 13: Cross-border investment: Considerations and risks
This chapter reflects on the increasing aim of financiers to invest in international real estate markets. Paige Mueller discusses the advantages of cross-border opportunities at length – such as the growth and size of international markets, the portfolio diversification, the appeal of higher yields than domestic markets – as well as the associated risks with investing offshore.

Chapter 14: Benchmarking real estate performance
Kevin Scherer analyses the utility of benchmarking in real estate investment strategy. According to Scherer, "proper benchmarking should be performed at multiple levels". This allows for a clearer understanding of where a property lies in comparison with its equivalent and a better estimation of its future performance. Both time-weighted and internal rate returns are explained at length, along with accompanying equations useful in their applications.

Section III: Fund and portfolio management

Chapter 15: Principles of real estate appraisal
Three most common theories for property appraisal – sales comparison, income capitalisation and cost approach – and their respective applications are described in this chapter. Authors Aart Hordijk and Peter van Arnhem also discuss the importance of international valuation standards, and their significance for international investors. Offering transmutable calculations, the chapter breaks down the fundamentals of real estate appraisal while offering insights for even the experienced investor.

Chapter 16: Valuation of income-producing real estate
This chapter challenges the use of all-risks yield valuation practices by offering a candidate for replacement: discounted cash flow (DCF). Phillip Gainey discusses the central aspects of DCF valuation, as well as how variations in the most common assumptions surrounding property investment worth can alter the valuation assigned to a given property. A summary of valuation assumptions is included at the conclusion of the chapter to provide readers with a succinct review of what aspects of their current valuation models of which they should be most sensitive.

Chapter 17: Management fee, carried interest and other economic terms of real estate funds
Derek Williams discusses the language behind real estate's sometimes abstruse terminology around deal structuring. This chapter attempts to more clearly define the key concepts that are employed in many complex private equity real estate transactions today – concepts such as carried interest, catch-ups and clawback are defined and examined in relation to their function for today's real estate investor.

Chapter 18: Mathematical concepts in building a real estate multi-manager portfolio
This chapter focuses on multiple management, specifically real estate multi-managers (REMM) or fund of funds. Emphasising a combined approach of top-down and bottom-up analysis, Edward Casal and Tiffany Thomas explore the mathematics behind REMM portfolios, highlighting the importance of an analysis that includes the portfolio strategy, manager and structure.

Chapter 19: Portfolio returns and volatilities through the cycles
In the last chapter of the book, Kenneth Riggs discusses the recurring cycles in the market and commercial real estate's role within those cycles. The aim is to connect real estate investment with these larger business cycles, and furthermore, to identify which portfolio strategies are most successful in certain cycles.

Understandably, any project such as this owes a great deal to its contributing authors. Their dedication and knowledge is evident in every page, and the freshness they have brought to this process cannot be understated. I extend my sincerest thanks to each of them. I also want to thank Wanching Leong of PEI for her professionalism and understanding. She was instrumental in bringing the project to life and contributed greatly to its smooth execution.

Last but not least, I would like to thank and acknowledge my co-editor, Tim Wang at Clarion Partners. His dedication has often meant bearing a heavier load, and this endeavour would not have come to fruition without his tireless efforts. Also thanks to Sabrina Martin for her organisational and editing skills, for keeping us on track and assisting in the copy-editing process.

Many thanks to all involved,

David Lynn, PhD

1 Private real estate allocations in multi-asset investment portfolios

By Greg MacKinnon, Pension Real Estate Association

Introduction

A wide variety of commercial real estate investment strategies can be employed within a multi-asset portfolio depending on the needs of the specific investor. For instance, opportunistic investment strategies tend to be alpha-oriented, attempting to generate excess risk-adjusted return, while core strategies tend to be geared towards diversification and ongoing income-generation. This chapter looks at commercial real estate investment from the perspective of a strategic asset-allocation decision.

In setting policy portfolios, it is typical to consider the investment characteristics of an asset class in general, rather than specific strategies that could be employed within the class. Hence, the focus is on the broad characteristics of equity investment in institutional-quality commercial property. Higher risk developments, turnaround situations and other strategies within the opportunistic and value-add spaces can certainly provide benefits to a portfolio if executed properly, but are not the focus here as the decisions involved with each investment are situation-specific. Rather, the chapter examines decisions taken from a portfolio-level: what benefits might an allocation to the broad real estate market provide to a mixed-asset portfolio, and how much should that allocation be?

The average institutional real estate allocation was 3.7 percent in 2010, although this varied by type of investor (see Table 1.1). A number of institutional investors have zero allocations to real estate, bringing down the overall average; among members of the Pension Real Estate Association (PREA), a trade association of the institutional real estate community whose members presumably have a high interest in the asset class, the average allocation to real estate was 9.8 percent in 2010.[1] It appears that once an institution makes a commitment to real estate as a viable asset class, real estate is allocated a significant portion of the overall portfolio.

Table 1.1: **Average real estate allocations of institutional investors, 2010**

All investors	3.7%
Public plans	5.0%
Corporate plans	1.3%
Others	4.4%

Source: PREA Investor Report 2011, Pension Real Estate Association.

[1] Pension Real Estate Association Investor Report 2011.

The standard arguments for real estate

The value of the global institutional-grade commercial real estate market has been estimated at $23.9 trillion, versus a total equity market capitalisation of $58 trillion.[2] An investor wishing to take a market-neutral approach would therefore need to have a sizeable allocation to property. Apart from its sizeable role in the universal market portfolio, several key arguments are often used to promote a real estate allocation, specifically real estate's provision of steady income, potential as an inflation hedge, good risk-adjusted returns and diversification benefits.

Income

In Figure 1.1 it is apparent that over the long-term price appreciation accounts for little of the total return to real estate, with income dominating.

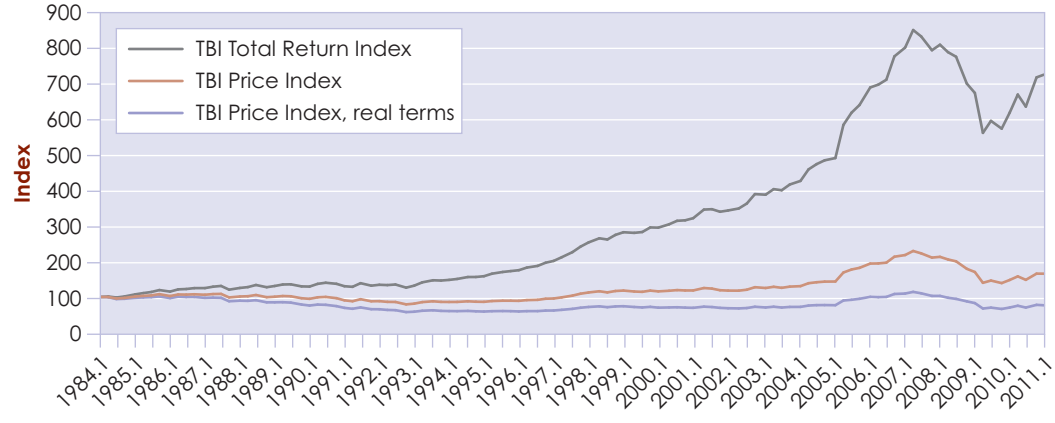
As well as being the dominant source of long-run returns, income returns from a diversified portfolio of real estate tend to be relatively stable. Using the variance of quarterly returns to the transaction-based index (TBI) as a measure of real estate risk for the 1984–2011 period:

$$\frac{\sigma^2_{price}}{\sigma^2_{total}} = \frac{0.00204}{0.00207} = 98\% \text{ of variance from prices}$$

$$\frac{\sigma^2_{income}}{\sigma^2_{total}} = \frac{0.000009}{0.00207} = 0.4\% \text{ of variance from income}$$

with the remainder of total risk arising from the correlation of income and price. Obviously, in a well-diversified real estate portfolio, income accounts for the majority of returns to real estate but very little of the risk. For institutional investors with ongoing cash outlay commitments, the provision of a stable income stream is an important advantage of the asset class that lends itself to higher real estate allocations.

Figure 1.1: **Income dominates as long run source of returns, 1984–2011**



Note: For period Q1-1994 to Q1-2011.
Source: MIT Centre for Real Estate, Bureau of Labour Statistics.

[2] Figures as of 2010 and May 2011, respectively. Sources: Prudential Real Estate Investors's A Bird's Eye View of Global Real Estate Markets: 2011 Update and World Federation of Exchanges.