

Industry Agenda

Understanding the Commercial Real Estate Investment Ecosystem

An Early Warning System Prototype

Prepared by the Steering and Advisory Committees of
the Shaping the Future of Real Estate - Asset Price Dynamics Initiative

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Prepared by the Steering and Advisory Committees of the Shaping the Future of Real Estate Project - An Industry Initiative on Asset Price Dynamics

*It is recognized that this paper contains material that ranges from **Basic** to **Sophisticated** and includes information from commercial real estate, to capital markets, to statistical modeling. For this reason, we suggest you use the Table of Contents like a “site map” for a website or a trail map for hiking or skiing. Select sections to read based on your interest level and level of difficulty. Based on this approach, some readers may be interested in reviewing the paper in its entirety, while others may want to focus their attention on specific areas and potentially go back to some sections at a later date.*

- **Basic**
- **Intermediate**
- ▲ **Sophisticated**

Further, this paper contains several quotes that may have a different tone than the overall paper. These various quotes are included for completeness and to illustrate the complexity and diversity of commercial real estate.

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Foreword

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Real estate valuations have become fairly expensive in 2015 and the current real estate cycle might be approaching the end of its lifespan. In US commercial property markets, for example, the Federal Reserve's first interest rate increase in nine years may very well signal the end of the real estate cycle that has seen nearly unprecedented price growth, with values for commercial real estate having doubled since the financial crisis and prices today in some markets being more than 20% above their previous peak in 2007.

Despite increased macroeconomic risk in the world economy, some real estate buyers are taking on increased debt in their real estate investments to ensure reasonable returns. At the same time, overall risk appetite among global real estate investors has already noticeably declined over the past year as China's market weakness, geopolitical turmoil in the Middle East and decreasing commodity prices prompt them to adopt more informed strategies.

Behavioural decision-making is key to understanding asset price dynamics, asset cycles and the macroeconomic links. The most destructive cycles were those in which asset price leverage and credits were intertwined, causing the greatest systemic effects. Asset pricing dynamics impact economies from the local to the global level. Policy-makers, industry leaders and academics are currently debating whether asset-pricing dynamics can, or should, be managed in the public interest. The Shaping the Future of Real Estate initiative delves into the mechanisms of asset pricing to learn how to detect when and why markets shift away from fundamentals and how negative consequences can be mitigated.

Within its first year, the initiative developed a strong brand by engaging leading experts, central bankers and businesses from the real estate, investors and financial services industries. At the World Economic Forum Annual Meeting 2015, the Forum released its first two reports on asset price dynamics with recommendations and case studies. The recommendations included both short- and long-term strategies for managing asset dynamics and the case studies highlighted both common and unique factors associated with the misalignment of markets. In 2015, the initiative focused on select recommendations made in the first year.

In 2015, high-level multistakeholder discussions took place to further define asset ecosystems and describe how the consequences of asset bubbles can be limited through innovative solutions. This year's focus was to help market players make more informed decisions. One work stream (summarized in this report) focused on designing a prototype early warning system to flag markets that may experience dramatic downturns; a second work stream focused on institutionalizing the team's insights and learning through developing an educational curriculum. The report on the second work stream showcases the boom and bust of the London office market from 1970 to 1976 in a comprehensive case study.

This year's reports are the direct result of a collaborative process with leaders from government, civil society and the private sector, in particular the real estate and financial services industries, as well as investors. In this regard, we would like to thank and acknowledge the Forum's Partner companies that served on this initiative's Steering Committee: Acciona Real Estate, BlackRock, Cantor Real Estate, Emaar Economic City, Hillwood/Perot Group, JLL, McGraw Hill Financial, Newmark Grubb Knight Frank, Pine River Capital Management LP, RMZ Corp., Standard & Poor's Ratings Services, The Durst Organization, Two Harbors Investment and WS Atkins/Faithful+Gould.

We would like to specially acknowledge Barry Gosin, Chief Executive Officer of Newmark Grubb Knight Frank, and Colin Dyer, President and Chief Executive Officer of JLL, for their relentless interest and commitment to serve as the Champions of the initiative, as well as their teams for their exceptional support of this initiative.

Furthermore, we would like to thank the many experts, central bankers and those in academia who contributed to the report through their role on the initiative's advisory committee: Mahmoud Hesham El Burai, Yongheng Deng, Nuno Fernandes, Steven R. Grenadier, Erkki Liikanen, Colin Lizieri, Prakash Loungani, Kiyohiko G. Nishimura, Ewald Nowotny, Venkatesh Panchapagesan, Alessandro Rebucci, Nouriel Roubini, Simon Rubinsohn, Nicholas Scarles, Robert J. Shiller, Didier Sornette, Katja Taipalus, Stijn Van Nieuwerburgh, Susan Wachter and Ko Wang.

The experience, perspective and guidance of all these people and organizations contributed substantially to a number of remarkable discussions during and following the World Economic Forum Annual Meeting 2015.

Foreword by the International Monetary Fund (IMF)

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Turns in the economy take economists, even the best of them, by surprise. In late-August 1990, Alan Greenspan, then chairman of the Federal Reserve, said that “those who argue that we are already in a recession are reasonably certain to be wrong”—of course, the recession had already begun. His successor, Ben Bernanke, predicted in 2007 that the “subprime problem [in the housing sector] is contained.” Yet, without forecasts, as this excellent new report from the World Economic Forum notes, we would be driving a car “while looking only in the rear view mirror rather than through the windscreen.”

There are few economic forecasts more important than those of the real estate sector. As Ed Leamer has said, “housing is the cycle.” Collapses in this sector have been associated with severe crises, including the global financial crises of recent years. While this crisis increased the spotlight on the residential sector, much less is known about the commercial real estate sector.

This report is thus welcome for the information it provides on the commercial real estate ecosystem—the main players and their motives. But the report is far more ambitious. Its goal is to provide an early warning system for commercial real estate crashes. Moreover, the intent is to build a system that can be scaled up to the global level—it is currently applied to 10 U.S. cities— and also applied to other asset classes, including the residential real estate sector.

So, does the effort succeed? Yes, in my view. The authors show that the risk of crashes in the commercial real estate prices in U.S. cities can be linked to developments in a few macroeconomic indicators—inflation rates, bond yields, consumer confidence, employment—and to growth in the sector’s net operating income. There is thus no complex or secret ingredient needed to assess the risks of crashes: one only has to look out the windscreen.

This is a useful exercise even if, as the authors readily admit, they do not try to understand the deep causes of what leads sharp run-ups in commercial real estate prices in the first place. As they note, often “one does not need to know the causes of a condition to be able to diagnose the effects of the condition.” Academics may have the luxury of debating what causes ‘bubbles’ in real estate markets—or indeed if they even exist—but policymakers have to deal with the consequences of cleaning up the mess when there is a crash, regardless of why it happened. Whether there was a bubble in house prices in Ireland in the 2000s will be the topic of numerous doctoral dissertations; what the policymaker takes from episode is that the cost of cleaning up after the crash was 40 percent of the country’s annual income.

The IMF is happy to have been part of the advisory and steering committee that has guided this report and the other important work carried out by the World Economic Forum’s Asset Dynamics group. We share the desire to pay close attention to the real estate sector, to devise policies to ward off crashes, and to put in place policies that will minimize the costs of crashes that will nevertheless occur. As our Deputy Managing Director Min Zhu declared in 2014, “the era of benign neglect of house price booms is over.” I look forward to the extension of the early warning system developed here to other cities and to sectors, including residential real estate.

Foreword by the Project Champion

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The basis for any market, including commercial real estate, is the ability to confidently and dynamically assign current and future value to the assets being exchanged as the market ebbs and flows. While a select few economists and academics have been able to accurately predict dramatic market shifts in commercial real estate, a devilishly complicated mix of heterogeneous assets, fragmentation, conflicts of interests, diverse metrics and an increasingly global investor pool, limit this predictive ability for even the most experienced practitioners and investors.

With first hand appreciation for the devastating economic, social and political effects that result when a market crashes, and with an intimate understanding of the potentially devastating and long lasting effects of commercial real estate crashes, this initiative sought to understand if there was a way to institutionalize the methodology associated with predicting dramatic commercial real estate market downturns.

In collaboration with the World Economic Forum, the Asset Price Dynamics Steering and Advisory Committees developed an Early Warning prototype that quantifies relative risk and signals dramatic market downturns. Used in conjunction with other methods and analysis, we believe such a system could increase overall market transparency and act as a “prophylactic” to help prevent destabilizing effects of capital rushing into and out of property markets during periods of dramatic change.

Some fear that such a system may curb further investment; we believe the contrary. Using data to understand market risk and its impact on asset values, investors, debt and equity providers, policy makers, and others may be encouraged to take smart risks, potentially increasing the pool of investors and spurring further investment in commercial real estate.

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Executive Briefing

Bubble: “When the prices of securities or other assets rise so sharply and at such a sustained rate that they exceed valuations justified by fundamentals, making a sudden collapse likely - at which point the bubble “bursts””.¹

Asset bubbles are the investment roller-coaster which results in both euphoria and motion sickness, the creator of fortunes and the grim reaper who takes them away. While economists continue their academic debate as to the existence of asset bubbles, investors, bankers, and the general public seem generally aware of bubble formation and the bubble bursts that follow.

Since 1975, there have been five generally recognized commercial real estate asset bubbles in the U.S. With the U.S. commercial real estate market currently estimated at approximately \$4.8 trillion, a bubble burst in this asset class could potentially deflate values by at least \$960 billion (where a 20% loss in value is a very conservative estimate for a significant market correction or bubble burst). Similar to natural disasters, the recovery after a dramatic downturn can be long and the cleanup can be arduous. This paper focuses on the feasibility of providing an advance warning system to signal market fluctuations (regardless of cause) in order to help moderate some of the adverse impacts of dramatic market swings.

As commercial real estate becomes more mainstream, price fluctuations have a broader impact on investors, markets and economies at large. While metrics and analytical tools are maturing, they continue to be imperfect for managing an asset class with heterogeneous assets, fragmentation, agency issues, and a lack of data transparency. Compared to other asset classes, even the U.S. property market lacks some key historic data to support extremely advanced modeling and decision making. Capitalization rates (a.k.a. “cap rates”), described as the first-year yield on cost an investor would receive on an all cash purchase, are recognized as the standard measure of yield for real estate and a key metric for comparing assets. However, the assumptions associated with the “cap rate” calculation are not always well documented, and do not account for varying lease terms, credit profiles, rent volatility, rent control or other market conditions which would logically influence investor behavior. Indexes have been successfully introduced, but a robust predictive Early Warning System that forecasts market movements and addresses both the illiquidity and unique risks associated with Commercial Real Estate (CRE) is not readily available.

In considering whether a commercial real estate Early Warning indicator was even feasible, efforts were consciously focused on creating an Early Warning prototype for office properties that could be tested in ten sample markets within the U.S. where preliminary data existed. The Early Warning prototype that was ultimately created suggests **that there is currently greater than a 70% chance of a downturn in the next year in at least six major office real estate markets in the U.S.**

In creating predictive models, much emphasis is put on identifying the “right” set of variables – that combination of inputs that collectively act as a trigger (or leading indicator) of things to come. In designing an Early Warning prototype for office real estate, many variables were considered. While other input variables may prove to be equally valuable in contributing to an Early Warning System, the following input variables were collectively found to be highly effective in predicting downturn dynamics in ten U.S. sample markets. Relative importance to the model can be attributed, with the following variables arranged in the order of their relative significance. *These input variables are further discussed in Section 2 of this document.*

- Change in Consumer Price Index (CPI) - national
- Change in Ten Year Bond Yield – national
- Change in Two Year Bond Yield – national
- Consumer Confidence – national
- Implied Net Operating Income (NOI) Growth – local
- Change in White Collar Employment - local

While identification of the appropriate input variables is critical for success, the selection of the appropriate modeling tools and methodology is equally important in designing a prototype model. The lack of historic data, the volatility of data, and the cyclicity of commercial real estate pose unique challenges from a modeling and methodology perspective, and a unique combination of models and approaches was required in designing the Early Warning prototype discussed in this paper.

The Early Warning prototype described in this paper consists of three components:

1. Value Index Creation – Creating a definition of the value that ties with the asset in question
2. Peak Tagging – Tag periods that represent peaks in the asset value
3. Risk Model Training – Train risk model to identify downturn risk using a combination of indicators

To obtain a consistent estimator of value we created an econometric model to estimate transaction cap rates, using the NCREIF appraisal data and several macroeconomic indicators. This Value Index model performs well (+90% r-squared) across our ten major metro sample markets. For Peak Tagging, when a market experiences a twenty percent increase over two years in cap rate spreads vs. ten year treasuries, the previous low point is tagged as a peak. *Value Indexing and Peak Tagging are further described in Section 2 and in Appendix 1 and 2.*

The third component, Risk Model Training is far more complex. In developing the proof of concept for this component, several models were considered - each with associated advantages and limitations. Logit/Probit models have been used before for event prediction, but suffer from an over-focus on the immediate predictors of an event, rather than the long run factors that have built to an imbalance. Hazard models (widely used in healthcare research) predict the current “risk of the event” which is useful for capturing the long run imbalances, but is not able to make forward looking predictions. To address these issues, a Hybrid model was created that retains the attractive features of both Logit/Probit and Hazards models. Using a Hybrid model for the prototype, a distribution of the probability of events at future periods can be produced at each period. *The Logit/Probit, Hazards Model and the Hybrid Model are further detailed in Appendix 3.*

The Hybrid Indicator prototype was applied to ten sample U.S. markets across the U.S. Twenty five years of data (from 1975-2000) was used to calibrate (“train”) the prototype; this is referred to as “in sample” data. The prototype was then validated (“tested”) against fifteen years of data spanning 2000 – 2015; this is referred to as “out of sample data”. Comparing the “in-sample” calibration data to the “out of sample” validation data produced a striking result: although the office real estate market has changed significantly since 2000, the underlying forces that lead to office “bubbles” and subsequent downturns appear to be the same and suggest that market fluctuations may be predictable. The Early Warning prototype accurately predicted bubble peaks in all ten sample markets.

While the Hybrid prototype has some limitations which are discussed in Appendix 3, the initial results suggest that despite differing motivations and incentives, an Early Warning System, used in conjunction with other analysis and metrics, could potentially be used by market players and market influencers to better plan and manage individual office real estate investments and the asset class at large. This has obvious implications at the highest levels (economies) down to the lowest levels (discreet investment decisions). *How representative market players could apply such an indicator is explored in Section 2.*

In addition to suggesting predictability, the development of the Early Warning prototype highlighted several other notable findings. These are summarized below.

– U.S Cap Rate Track Nationally

While each local market within the United States has some unique characteristics, cities of similar sizes tend to hold similar attraction for investors: small cities draw modest investor demand, with investors concerned over lack of liquidity and smaller pool of qualified tenants for re-leasing at expiration; large cities, conversely, draw disproportionately higher investor demand with perception of increased liquidity and higher population of qualified tenants for re-leasing. As a consequence, small cities carry a risk premium over large cities which is reflected in the cap rates for these different markets. While small cities can attract national or global investors, those cities attract national and global investors looking for higher yield than they can otherwise achieve in larger cities. As a consequence, despite regional economic differences, major U.S. markets cap rates tend to move at similar times—either up or down—reflecting the national and global appetite of property investors tracking opportunities between markets. Risk premiums increase or decrease in proportion to overall market exuberance, with periods of very high investor demand helping to decrease risk premiums while periods of lower investor demand exaggerate risk premiums between markets of different sizes or global awareness.

– Optimism Prevails

In reviewing transaction assumptions, expected annual dividend growth projections are optimistic a majority of the time. Specifically, expected Annual Dividend Growth is almost always projected at a higher level than the Long Term Expected Annual Dividend Growth rate. This optimistic perception can contribute to overvaluation.

– Conditions, not Time Determines the Probability of a Downturn

Time does not appear to be a determinant factor in bubble formation or subsequent market corrections. Intervals between tagged bubbles ranged from four to ten years, reflecting a convergence of conditions that have repetitively existed – but do not have to exist. The temptation to say we are “due for” a bubble or subsequent correction based solely on interval should be resisted.

To fully grasp the potential uses and the limitations of an Early Warning System and to appreciate the key findings introduced above, one must have a basic understanding of the underlying Commercial Real Estate Investment ecosystem. Commercial real estate (inclusive of agricultural land), is the oldest investment asset class, but not the most transparent or the best understood. Once dominated by wealthy individuals, this asset class is now aggressively sought by diverse investors as a primary asset. Straight forward financing has been augmented by complex financial instruments. Assets and portfolios are constantly being restructured and real estate has shifted from a local to a global asset.

The Commercial Real Estate Investment ecosystem is fueled by a variety of debt and equity investors and the assets are managed by a combination of Investment Managers and Professional Real Estate Managers. The motivations of these market players vary greatly and their primary focus ranges from Income, to Fees, to Capital Appreciation and Preservation. With different (and often competing) motivations, the various market players use different KPIs (key performance indicators) to measure success and different operational metrics to manage day-to-day tactical decisions. As previously mentioned, “cap rates” are considered a universal metric used by a variety of market players. The cap rate is a single-period value metric which describes pricing as a function of the first year’s unlevered yield. The cap rate does not explicitly address multi-period factors involving contract rent changes over time, residual value risk at expiration of rental contract, or collection risk during contract terms. Rather, it is used as a simple market metric to compare yields of different trading assets—both within and between different markets. Cap rates are widely used by Investors, Brokers, Analysts, and Managers alike.

It may be a lofty goal, but over time, an Early Warning System could potentially achieve the mass appeal that “cap rates” currently enjoy: a market indicator which sophisticated investors, occupiers, developers and lenders consider when determining whether to buy, build, lend, sell or lease properties. If and when an Early Warning System were to gain traction, it would not be a “silver bullet”; while accretive, it would not replace market and asset based analysis used today. *The Commercial Real Estate Investment ecosystem and related metrics are further described in Section 3 and 4.*

The Early Warning System prototype described in this paper was intended to help mitigate risk, but it does not represent the end of this line of inquiry. It is the beginning of a more quantitative approach to real estate investment as the industry transitions from “limited data” to “big data”. The Early Warning prototype was also designed to be flexible. Like other industry innovations, it is subject to refinement over time and could be paired with more contemporary data points as data becomes available. While the prototype developed focuses on office markets in the U.S., the methodology may be scalable to other markets inside and outside of the U.S. as well as other asset classes – most notably and immediately with residential real estate.

While an Early Warning System can theoretically enhance decision making and level the playing field across a broadening investor base, it cannot fundamentally change human behavior. A competitive spirit, greed, fear, status, herding behavior and many other intrinsic factors will continue to influence investment perceptions and behaviors – no matter how much data and information is available. Despite the human condition, the Early Warning prototype presented in this paper has the potential to help create value for tenants, investors, policy makers and regular individuals through contributing to a more transparent property market. In this way, participants across the CRE ecosystem can collectively help mitigate the ill effects of dramatic downturns. Whether market makers and influencers are willing to embrace this innovative approach remains to be seen.

The purpose of this paper is twofold. It seeks to be innovative for more seasoned readers and educational for those seeking more understanding. Section 1 is an Introduction to Commercial Real Estate fundamentals and includes a discussion on why it has been difficult to create a predictive model in the past. Section 2 describes the Early Warning prototype and includes outputs and applications. Section 3 describes the underlying Ecosystem - the players and influencers who could use an Early Warning System and Section 4 focuses on Metrics - some of which are variables used in the warning system and some of which could be used in conjunction with the outputs of a Warning System. The Conclusion is contained in Section 5. There are also several appendixes accompanying this document. Appendix 1 and 2 describe the Indexing and Tagging components of the prototype. Appendix 3 describes the Training component of the prototype.

Endnotes

1. FINANCIAL TIMES, [ft.com/lexicon](https://www.ft.com/lexicon)

I. Introduction •

This section introduces the concept of a Commercial Real Estate (CRE) downturn indicator prototype. Market fundamentals are summarized and several commonly held misconceptions about CRE are addressed.

Design Considerations

The Early Warning System prototype predicts there is a greater than 70% chance of a downturn in the next year in at least six major commercial real estate markets in the US.

Would having this type of information change your investment strategy? Your management strategy? Your macro prudential policies? What if every quarter you could access this type of information to see if the probability was increasing to say 80%...or decreasing to 60%? What if you could change the time interval on a sliding scale to change the outlook from 12 months to 24 months? How would you use this predictive information?

While commercial real estate has become mainstream, it is still a relatively illiquid “long lead time” asset. When the market changes, it is difficult to quickly divest of or invest in commercial real estate assets because the assets are heterogeneous and it takes considerable time to establish market value. Transaction closings are often reflective of values negotiated six months prior (accounting for time to conduct contract negotiations, conduct due diligence, and arrange financing), causing a lag in value adjustments to market conditions. Further, commercial real estate lending relies upon appraisals to establish value comparisons. In a severe market correction, appraisers generally disregard closings from distressed sales in establishing current market values. Finding sufficient arms-length (i.e., not distressed) market sales comparables to support “corrected” values can often take two years or more to be reflected in area values. This time period is often characterized by lack of sales activity, with a considerable gap between the “bid” (what investors are willing to pay for properties) and the “ask” (the price at which sellers are willing to sell their properties). Sellers with insufficient cash flow or cash reserves to wait for their asking price to be met by market conditions can find themselves in distress, with a lender repossessing the asset or forcing a sale: in either case, the distressed value is not generally reflected as an arms-length sales comparable which can be used to establish market value, thus enforcing a cycle of illiquidity and a very slow market recovery.

To mitigate and manage some of the ill effects associated with drastic market swings, we set out to determine the feasibility of developing an Early Warning prototype to give market players visibility to predicted market changes.

To design and develop an Early Warning prototype, we needed to:

- Bring together a diverse **cross section** of academics, economists, and industry leaders to provide input
- Create a prototype that was **quantitative and predictive**, but not prescriptive. The prototype could share the probability of a downturn, but let individual investors and managers decide what is the best action based on their specific strategy and risk profile
- Make the prototype **practical**, so it could be applied to current investment and management decisions
- Accept the fact that a prototype created in a compressed timeframe may have limitations, but would serve as a **launching point** for further discovery and development
- Design the prototype to **scale** so that it could potentially be applied to other asset classes and other markets in the future
- Integrate **market fundamentals** into the prototype model

Overview of Market Fundamentals

Commercial Real Estate Market Fundamentals

The Commercial Real Estate market is a well-known but little understood and highly illiquid marketplace. Like most markets, pricing is influenced by supply and demand characteristics.

These traditional components of economic behavior are relatively simple to gauge. The supply of available competing space is forecast well in advance, thanks to the time it takes to bring product to market. Demand from competing occupiers is typically well understood and reported in most markets due to a highly competitive brokerage community. So what is it about the commercial real estate market that gets so complicated?

Long-Term Rental Contracts

The rental contract used to codify the agreements injects a temporal restriction which contributes to the market illiquidity: occupiers contractually commit to space for a period of 5 to 10 years in many markets, with terms of 10-20 years common in certain core commercial centers. These long term contracts are considered acceptable due to the significant capital investment required to prepare these offices for their intended occupier use: international accounting regulations require occupiers to amortize their capital investment over their lease term and book the amortization as a period expense during each year of the lease. Longer terms reduce the annual amortization expense for occupiers, thereby improving their fiscal performance.

Because business needs are highly variable over time—with an ever increasing pattern of variability—the long term nature of property leases tends to confound the short-term planning horizon of many occupier/tenants. Depending on the planning horizon and availability of capital, occupiers will tend to either under-commit for space or over-commit for space. The inevitable result is a need to grow, shrink, or relocate long before the natural lease termination. If the occupier is in a downward market and finds they need to shrink before the lease expiration, their choices are to sublease or attempt to negotiate an early lease termination/lease buyout with the landlord. In a market of decreasing demand, landlords are generally reluctant to accept a buyout—effectively making a sublease as the primary (or only) option. In order to compel sub-tenants to take on lease space and contractual restrictions previously negotiated—providing little or no contractual latitude—and to commit sooner in order to accelerate the period of sublease expense recovery, occupiers tend to discount their lease rate relative to the general market. This discounting can often accelerate a market-rate decline, as subleases compete with direct lease spaces for the same tenants, deepening the deficit from normalized market conditions.

Capital Asset Value

Capital asset values for income properties are primarily a function of scheduled income over time and residual value of the asset after lease expiration, weighed against application of the cost of capital across both equity and debt components of the capital stack. A discounted cash flow analysis is the

method by which investors establish current value after application of these different risk components which comprise their discount rate and borrowing rate. Investor discount rates and borrowing rates can vary significantly over time due to macroeconomic forces (Fed borrowing rate, 10 year Treasury rate, jobless rate, etc.) and microeconomic forces (local market supply/demand, local employment, municipal solvency, etc.). After a severe market correction, asset values can tumble as both discount rates and borrowing rates increase significantly to reflect revised risk appetites under the market correction—all made without any change to underlying income. *(Note: To be sure, the Great Recession caused many existing lease contracts to be re-negotiated, lowering rents in order to help tenants maintain solvency. This re-negotiation also forced loan restructuring, as lenders agreed to reduce interest rates or halt principal repayments in order to prevent wholesale market implosion. And of course, lender restructuring caused banks to fall below their minimum capital levels, which led to the Federal government providing capital support to shore up the banking sector. But the extent of the market correction during the Great Recession was unusually large and the impacts particularly widespread. This level of contractual renegotiation is quite unusual on a historical basis.)* While investors use a discounted cash flow to determine value, the industry reports value using the more simplified “cap rate” method, a single period analysis which expresses the first-year return as a percentage of the overall acquisition cost. For simplicity, this paper will focus on cap rates as an accepted proxy for capital valuation of income properties.

Not Commodities: The fallacy of “Location, Location, Location”

Office buildings are an interesting blend of function (degree to which building can physically accommodate different occupier demands and configurations) and form (exterior and interior design, finish quality, and configuration of both public and private spaces). Location within a property submarket, availability/proximity of parking, building and nearby amenities, and accessibility to public transportation all influence individual property performance within a given market. The confluence of form, function, and location drive suitability for any given occupier. Importantly, however, is the point that different occupiers have different needs criteria: for some, proximity to public transit will be the most important criteria. For others, building design, quality, height, and views will be the most important criteria. For others still, cost becomes the most heavily weighted decision attribute. There is no single “right answer” for all occupiers; rather it is the diversity of the market which creates the right balance. This all contributes to illiquidity of real estate assets as buildings are not commodities: each has unique attributes which appeal to different occupiers, lenders, and investors.

Capital Market Influence

Where entrepreneurial owners historically sourced equity investment from local sources, increasingly equity is coming from institutional owners and large investors on a regional, national, or global basis. Similarly, debt is sourced from regional, national, or global sources. While debt and equity providers theoretically understand that real estate occupancy is illiquid and varies according to local and national economic forces, they have limited tolerance for income falling below required payment levels: lenders and equity investors are both compelled to make significant

disclosures relative to non-payment risk, with asset mark-down or accruals taken as a precautionary measure to characterize failure of contract terms or changes from original investment thesis. On a debt basis, these changes can cause re-balancing of the loan and force borrowers to pay down the remaining balance on their loan. For an equity investor, changes to pro-forma income can have longstanding and negative impact on their ability to attract capital for new investments. Simply said: investors and lenders love making money, but are considerably more reserved about losing money on their investments. Asset losses tend to force movement between asset classes—away from those assets experiencing loss and toward those assets experiencing higher returns and/or toward assets thought to better preserve capital investment. Vacating tenants and down markets therefore have far reaching impacts on availability of capital for real estate—both in terms of their level of influence in forcing recapitalization and re-tenanting plans as well as their desire to maintain real estate market exposure.

As such, capital availability swings in a similar fashion to occupier space demand: when demand is high and supply is low, more and more lenders desire to commit ever-greater amounts of capital; when demand is low and supply is high, more and more lenders are motivated to shed real estate loans and assets and retreat to other and more liquid investment classes. This capital “faucet” turns quickly from high capital availability to very limited capital availability in a severe downturn and can create some destabilizing impacts on the property market, as the vast majority of occupier demand remains relatively constant throughout varying market cycles. Businesses which have needs to expand or relocate in a down market are severely restricted in their ability to find development partners which have sufficient capital availability and borrowing capacity to accommodate required capital investment.

Market Illiquidity and Value Cyclicity

While commercial real estate over the long term delivers consistent returns comprised of both income and capital appreciation, value is not delivered in a linear fashion. Rather, value is gained on occupancy, enhanced on market cap rate compression, eroded on market cap/interest rate increases, and lost on vacancy (when cash flow moves from positive to negative). These variations do not make real estate investing inherently unsafe, but instead illustrate how real estate is a cyclical investment which experiences significant pricing variation depending on the cyclical stage. This inherent variation enhances asset illiquidity over time, as different investors have varying capability to address asset risk at different stages.

Bubble Effect

Taken together, the commercial real estate market illiquidity can result in asset bubbles—which are the subject of this paper. While the bubble formation can have very positive and far-reaching impacts on investors and cities—in terms of wealth creation, physical form of cities including both buildings and infrastructure, and general societal advancement—bubble “popping” and the resulting severe downturn can have longstanding and widespread negative impacts. As real estate economists and practitioners, we are compelled to find solutions to mitigate the ill-effects of burst bubbles in order to reduce the pricing variation and drive toward long term market stability.

What’s a “Bubble” & Why Isn’t an Early Warning System Readily Available?

While a lot of academic, economic and industry data has been published on real estate bubbles, the bulk of the research has focused on residential as opposed to commercial real estate. Strides have been made to better understand real estate cycles and bubbles and last year’s World Economic Forum (WEF) Emerging Horizons in Real Estate, An Industry Initiative on Asset Price Dynamics Executive Case Studies and Profiles Prescriptions and Proposals have increased awareness. However, there are still several misconceptions regarding commercial real estate asset bubbles that have hampered the ability to leverage existing data and metrics to develop and implement an Early Warning prototype to signal overheated markets and subsequent downturns.

The following addresses some of these misconceptions – to separate the facts from the fallacies, and to pave the way for introducing an Early Warning prototype that may be improved over time.

1. **Belief: There is no universal definition for asset “bubble” – and any definition should distinguish a cycle from a “bubble”**

While economists and academics continue to debate the existence of asset bubbles, one source describes a bubble as follows. *“When the prices of securities or other assets rise so sharply and at such a sustained rate that they exceed valuations justified by fundamentals, making a sudden collapse likely - at which point the bubble ‘bursts’”*.¹ In speaking with representatives from across the Commercial Real Estate Investment ecosystem, we have concluded that while there is not agreement on how to measure a bubble, there appears to be a general agreement on how to describe a commercial real asset bubble. A bubble can be described as ***an environment in which both actions (e.g. appraisals, valuations, and transactions) and perceptions (e.g. discounted cash flow projections) and actual prices become “detached” from market supply/demand fundamentals. Prices rise so sharply and at such a sustained rate that a sudden collapse is likely.***

Much of the market is based on looking backward rather than looking forward. Imagine trying to drive a car by looking only at the rearview mirror rather than through the windshield—a crash is not only likely, it is inevitable. CRE appraisals—the basis of most equity and debt involvement in CRE—are primarily a backward-looking form of analysis. They estimate current value by evaluating assets against those which have already transacted. Similarly, lenders evaluate potential projects by first viewing the success of projects which have already been completed. While future viability may be informed by past success, market changes need to be evaluated by looking forward rather than backward.

Since fundamentals cannot be observed in real time, for the purposes of this paper, we define the peak of a bubble as the time preceding a greater than 20% drop in value (defined as an increase in cap rate spreads) over a two year time frame.

2. **Belief: If you are in it for the long haul, you don't need an Early Warning indicator when the markets shift, because real estate is always a good investment and real estate markets are self-regulating**

Similar to the misconception that stocks are always the best investment in the long run, commercial real estate is not always the best investment (vis-à-vis other options) even if it is held for over several years. The former misconception is well documented in Asset Dynamics Advisory Committee member Robert Shiller's seminal book *Irrational Exuberance*². If one were to review real estate cap rate data and adjust for inflation with CPI data, one would see that over time real estate can sometimes bring very modest returns.

"Real estate is like a lot of asset classes...big boy games - if you want to play, either you or your partners need to understand how it all works"

WEF Asset Dynamics Steering/Advisory Committee Member

This is not to suggest that commercial real estate is never a good investment – just an acknowledgement that like other asset classes, commercial real estate risk should be consciously managed.

More mature and liquid markets rely on the market participants to "signal" their perceptions through their market actions – by buying and selling. The collective actions of all the market participants act as a signal and other participants respond accordingly to "regulate" the market. There are two problems with this concept – 1. Liquidity and 2. An assumption that everyone has all the information they need to make informed rational decisions and everyone cannot be wrong.

Since real estate, particularly commercial real estate, is not a liquid asset and transaction lead times can be 6 to 12 months, market participants cannot "signal" the market effectively because their options are limited based on liquidity. In addition, the ability to respond to and stabilize the market through hedging strategies is greatly limited in commercial real estate; specifically, the ability to "short", to make money on falling values, is virtually non-existent.

Even though liquidity limits the ability to respond to fluctuations in the market, the commercial real estate investment market often responds to fluctuations en-masse. Independent perceptions and actions are compounded across the ecosystem. The media selectively highlights stories that legitimize out of balance conditions, investors seek out experts to validate their beliefs and more and more people jump on the bandwagon. In this environment, "information cascades" are created. These information cascades are defined as follows: *"a situation where each person makes a decision/choice based on the observations or choices of others while ignoring his own personal information. Information cascade is a theory used in the field of behavioral economics as well as other social sciences. Informational cascades can be observed in various scenarios including financial markets, politics, and business strategies. Information cascades generally develop when there is no direct verbal communication between individuals"*.³

If the first decisions of the first individuals are irrational, this

irrationality could be repeated and therefore compounded through herding behavior. This type of contagion behavior can result in asset spirals, which are well documented and includes work done by Markus Brunnermeier and others.⁴

3. **Belief: Any relevant research on commercial real estate "bubbles" must explicitly address the cause of "bubbles"**

While there are often common conditions that contribute to a real estate asset bubble (e.g. easy access to capital), the underlying causes of "bubble" vary broadly.⁵ Determining bubble causes is a very worthwhile effort, but one does not necessarily need to know the specific causes of a condition to be able to diagnose the effects of the condition. The prototype indicator described in this paper is agnostic to the cause.

While determining the causes of individual bubbles may not be a prerequisite for developing a prototype indicator, a basic understanding of the underlying ecosystem is necessary to be able to effectively understand the outputs of the indicator. *The underlying ecosystem for Commercial Real Estate Investing is described in Section 3 of this document.*

The Early Warning prototype discussed in this paper is focused on downturns in value, regardless of cause. The prototype indicator does not make any attempt to statistically remove bubbles peaks and subsequent downturns that arise from exogenous events, those events that "come from the outside" of the capital markets and real estate ecosystems... such as natural disasters or wars.

4. **Belief: Bubble bursts are not predictable...and even if we knew how to predict them, we do not have the data to do so**

Katja Taipalus, a member of the Asset Dynamics Advisory Committee, demonstrated that traditional Dickey Fuller and Augmented Dickey Fuller tests could be used to signal stock market bubble dynamics.⁶ Taipalus's model signaled up to 12 months ahead of a stock market bust. If Taipalus could predict stock market bursts with one variable (dividend yields), was there an available data set and model that could predict office real estate bubble bursts?

Fortunately, while a long time series is required, we found that only a handful of input variables were required to develop a stable Early Warning prototype for signaling office bubble dynamic. A description of the prototype and the input variables are described in the following section.

Endnotes

1. FINANCIAL TIMES, ft.com/lexicon
2. Shiller, Robert J 2015 *Irrational Exuberance*, Third Edition
3. Jain, Patik <http://www.investopedia.com/articles/investing/052715/guide-understanding-information-cascades.asp>
4. Brunnermeier, Markus and Oehmke, Martin June 6, 2012 "Bubbles, Financial Crises, and Systemic Risk" a chapter in *Handbook of the Economics of Finance*, Volume 2, George M. Constantinides, Milton Harris and Rene M. Stulz, eds., North Holland, October 2012
5. World Economic Forum, Jan 2015, *Emerging Horizons in Real Estate. An Industry Initiative on Asset Dynamics . Executive Case Studies*
6. Taipalus, Katja 2012 "Detecting asset price bubbles with time-series methods", Bank of Finland Scientific Monographs E47

This section describes the Early Warning prototype and

II. The early warning downturn indicator

the model that was developed to enable it. Outputs are presented and application case studies are included. Limitations and the ability to scale the prototype to other markets and asset classes are discussed.

“Based on the outputs of the Early Warning prototype, we predict that there is currently a greater than 70% chance of a downturn in the next year in at least six major commercial real estate markets in the US.” The predictive prototype we use to make this claim has been validated in ten U.S. sample markets, with data stretching back to 1978.

When an indicator such as the prototype described in this paper, is combined with traditional real estate portfolio analysis, risk mitigation capabilities to real estate investors and managers could be improved. Simply said, an early warning indicator could potentially enable real estate investors to make more informed decisions relative to their office property holdings by looking forward. Such a system could also inform other market participants (such as debt issuers and central banks) with respect to capital markets lending practices and macro prudential policy decisions.

Before expressing the details of the prototype, it is important to give an explanation of the intuition behind it, as well as the previous work that has led to this intuition.

Prototype Intuition ●

It has long been recognized that asset returns are not normally distributed. (Mandelbrot, (Oct., 1963)) This finding has also been confirmed in real estate returns. (Michael S. Young, May 1995) Commercial real estate is not a liquid asset, and in addition to “normal” market volatility, investors must also consider the possibility of large downturns aka the “ruin aversion” where investors shy away from transactions that have a potential for catastrophic consequences – even if the probability of those consequences is very low. (Janecek, May 11, 2004) These downturns are especially painful in real estate as market illiquidity can lead to investors to be “locked in” for the duration of the downturn.

To develop a forward looking prototype indicator of commercial real estate downturn risk, it is important to recognize that assessing the “risk” of a downturn is not the same exercise as A) assessing the cause of a downturn, B) assessing the causes of an overheated market or C) understanding the mechanics of an overheating market. In last year’s paper, many different causes of both overheated markets and downturns were discussed; this information may have utility for policy makers in the creation of regulations, but because so many of these causes are either unobservable (i.e. agency problems) or difficult to quantify (i.e. underwriting standards), those case studies need to be augmented with practical tools for those who are less interested in how markets work, and more interested in the how market dynamics impact returns.

The world as seen by the model



Real estate markets are characterized by heterogeneity, high search costs, and imperfect information. Theoretical work suggests the most effective policy option for this type of market is to provide timely and useful information to investors. (Schwartz & Wilde, (Spring, 1982)) If we can develop tools to make useful inferences for investors and other market players, that knowledge can potentially be utilized in decision making; the most direct path for market interventions.

For the purposes of analysis, it is useful to think of the real estate market as a “black box”. We can observe various inputs and outputs of this system, for example interest rates, asset prices, rents, construction, and others. The mechanics of the system, investor attitudes, agency problems, information issues, are not directly observed.

If we characterize some asset price dynamics as “downturns” (large drops in commercial real estate values), then the question of an Early Warning System becomes “what did we observe in the system input and outputs in the time period leading up to a downturn?” How accurate can we be using a model that does not directly confront the underlying mechanics of the real estate market?

Overview of Early Warning Prototype ▲

The Early Warning prototype described in this paper consists of three components

1. Value Index Creation – Creating a definition of the value that ties with the asset in question
2. Peak Tagging – Tag periods that represent peaks in the asset value
3. Risk Model Training – Train risk model to identify downturn risk using a combination of indicators

Value Index Creation

One of the most common objections to any model of this type is that the mechanics of markets change. The factors that contribute to an overheated market, and the subsequent downturn, have varied between cycles. Working in 1977, no one could have seen the way that mortgage backed securities would play out in 2007-8. The only way to make sure that the model is describing some long-run dynamic of real estate markets is to make sure we are using a long historical time series, on a number of different markets. This was a major challenge in model construction, as most of the time series variables suggested by last year's paper only go back to the late 90's. A series that describes real estate values over a long history is vital.

To describe real estate markets, cap rates are the most universally accepted value metric. Transaction cap rates are the best indicator of commercial values over time, as these represent empirical market values of commercial properties, but difficult to get over a long history. RCA data (Source: Real Capital Analytics www.rcanalytics.com) are a mix of transaction and appraisal cap rates, but are only available since 2001. Appraisal based cap rates are available from NCREIF (National Council of Real Estate Investment Fiduciaries www.ncreif.org) over a longer time horizon, but do not always reflect market cycles. This is most likely due to the backward looking nature of appraisal valuation.

For example, in reviewing appraisal cap rate data in NYC, it appears that the appraisal cap rates do not reflect the effects of the 2009 financial crises. We see this result across markets and in the NCREIF transaction cap rate data for prior periods. This result has also been found in the literature. (Petros Sivitanides, March 2001). To obtain a consistent estimator of value we created an econometric model to estimate transaction cap rates, using the NCREIF appraisal data and several macroeconomic indicators. This model performs well (+90% r-squared) across the ten major metro markets in the U.S. under study. In addition to checking the statistical measures of accuracy, the transaction cap rate predictions can also be cross checked against the limited transaction data we have available in the 1977 to 1989 period. The predicted cap rates largely agree with the limited data from this period.

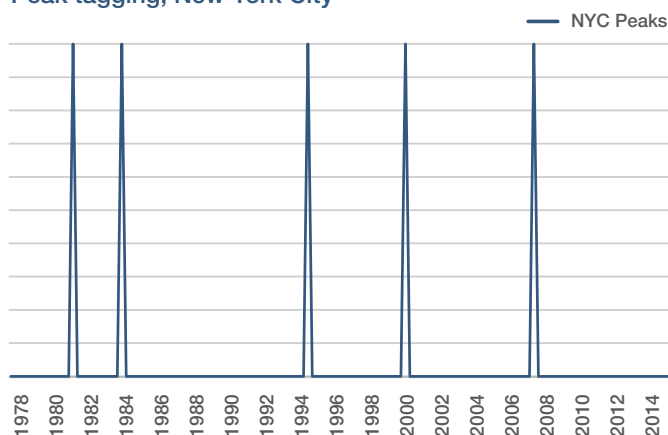
For additional information on cap rates and their applications, see pgs. 30-31. For more information on Indexing see Appendix 1.

Peak Tagging

For each of the ten U.S. sample markets, market peaks had to be identified. (A list of the ten sample markets is found on pages 18). After several iterations, a drawdown methodology was selected for tagging peak periods. When a market experiences a twenty percent increase over two years in cap rate spreads vs. ten year treasuries, the previous low point is tagged as a peak. Given the inverted spread relationship that occurred in the early 80's (ten year yield at 14%, metro cap rates at 8%), we also applied some de-trending to this spread. *For more information and examples on Peak Tagging see Appendix 2.*

The results for New York City are shown in the graph below. Peaks are identified in 1981, 1984, 1994, 2000 and 2007. This largely agrees with market practitioners' experience of market peaks. The only notable exception is the Savings and Loan crisis in the late 80's. This crisis occurred within the overall context of a booming market, and thus our drawdown calculation never finds a peak. One possible direction for future development would be the use of calculated market risk premia for commercial assets, which will provide a better theoretical backing than cap rate spreads.

Peak tagging, New York City



Risk Model Training

The final step is to train the prototype to identify downturn risk by predicting peak periods. This involves using prior data to accurately predict observed market downturns. To ensure that the model performs over time, the data were separated into an in-sample set (pre-2000) and an out of sample set (post-2000).

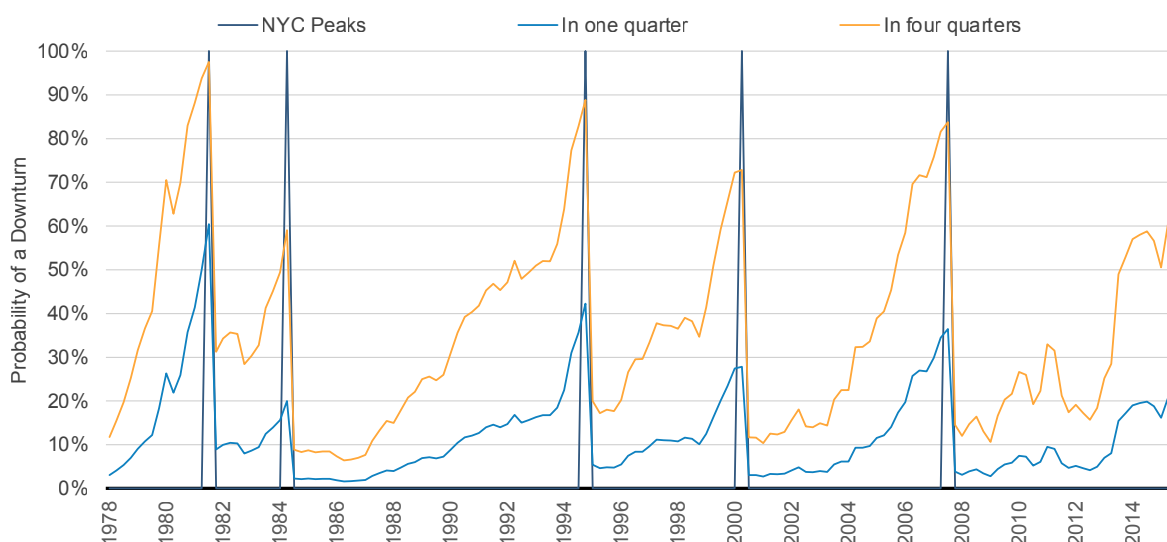
In developing the proof of concept for this component, several models were considered - each with associated advantages and limitations. Originally a Logit model was used, but the results were too binary and did not illustrate that bubbles slowly build over time. Logit/Probit models have been used before for event prediction, but suffer from an over-focus on the immediate predictors of an event, rather than the long run factors that have built to an imbalance. In order to avoid this binary "stoplight" indicator, a variation of a Hazards model was considered instead. (Gill, 1982) Hazard models (widely used in healthcare research) predict the current "risk of the event" which is useful for capturing the long run imbalances, but is not able to make forward looking predictions. To address these issues, a unique Hybrid model was created that retains the attractive features of both Logit/Probit and Hazards models. Using a Hybrid model for the prototype, a distribution of the probability of events at future periods can be produced at each period. *The Logit/Probit, Hazards Model and the Hybrid Model uses and limitations are further detailed in Appendix 3.*

The model states that there is some “baseline hazard” of a downturn, which is modified by observed market data. The resulting indicator, expressed as a probability that a downturn will occur in a specified period of time, is instructive but not prescriptive and acknowledges that different investors have different risk profiles.

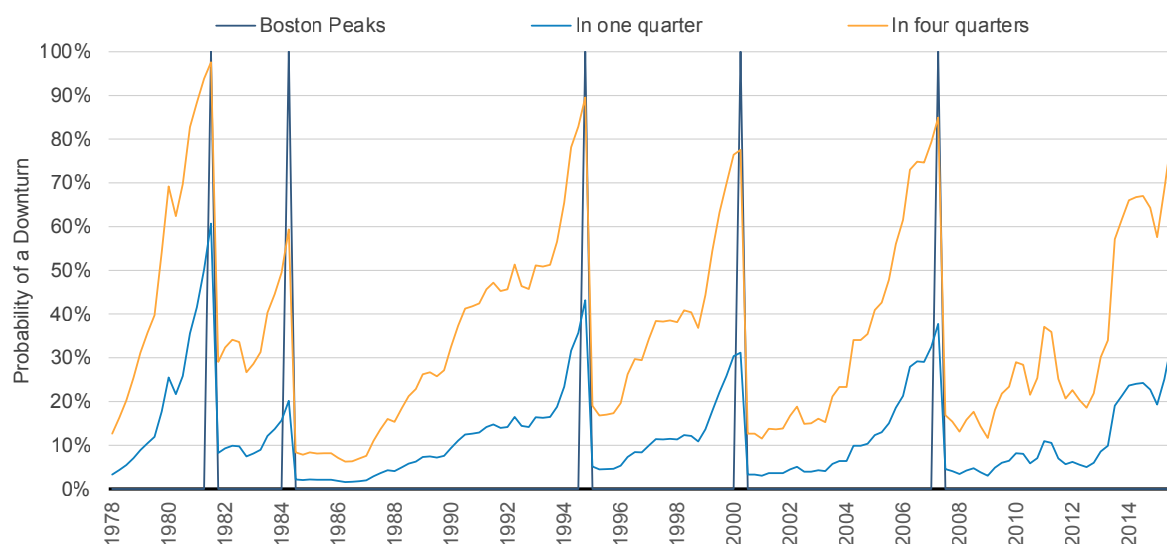
Pages 17-18 contain three outputs graphs from the Early Warning prototype created by NGKF. The results for NYC are shown in the graph below. The model performs quite well, beating out the un-aided baseline model (no one knows when the next downturn will be) and the time based event model (downturns happen about every X years), by several orders of magnitude in likelihood. The model was not tested against a “cap rate reversion to the mean” model, as cap rates were used to define peak tags, and thus using them as a predictive variable invites “look ahead” bias. The blue lines are observed peaks (followed by downturns) in the real estate market, the red line is the probability that a peak and subsequent downturn will occur in the next quarter, and the green is the probability that a peak and subsequent downturn will occur in the next four quarters. For example, the 2007 downturn is predicted with substantial accuracy. In 2004, the chart illustrates that there is about a 5% probability of a downturn in the next month and over a 20% chance in the next four quarters.

One of the benefits of this type of model is that it recognizes that different investors have different horizons of concern. The model can give the downturn probability for any desired future interval and help investors with different risk appetites make decisions accordingly. Investors and other market players looking for information about the next 1 year, 2 years or even 3 years can all be satisfied. Edge cases are also handled in the appropriate way. (I.e. The probability of a downturn in the next 20 years is ~100%). *Additional information on the model can be found in Appendix 3.*

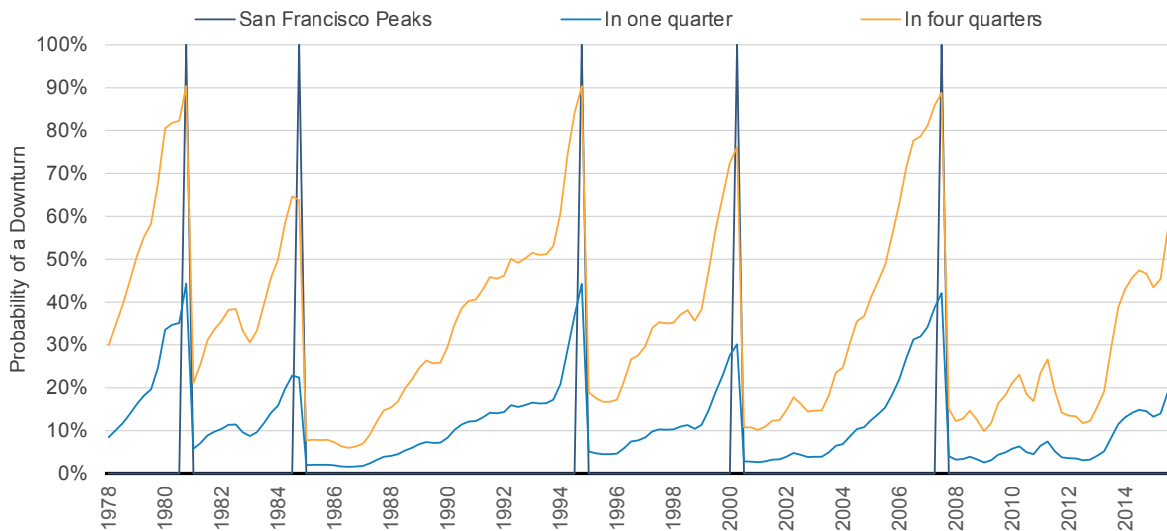
Early Warning Prototype Output, New York City



Early Warning Prototype Output, Boston



Early Warning Prototype Output, San Francisco



Similar results were found in all 10 sample markets. Outputs from seven of the markets are found in Appendix 3

- San Francisco (see above)
- San Jose (see appendix)
- NYC (see above)
- Miami (see appendix)
- Boston (see above)
- LA/Orange county (see appendix)
- Denver (see appendix)
- DC (see appendix)
- Chicago (see appendix)
- Atlanta (see appendix)

Early Warning Prototype Variables

Several potential variables were evaluated to determine if they would be good predictors for a commercial real estate Early Warning prototype. For many of the variables considered, there was not enough history to calibrate and validate the prototype model.

The chart on the following page contains representative variables with less than 20 years of history.

While other input variables may prove to be equally predictive, the following were collectively determined to be good predictors of commercial real estate bubbles. These are presented in order of significance to the prototype developed. The first four variables were chosen mostly for their broad influence on valuation of assets and the state of the economy, rather than any commercial real estate specific reason. The final two were chosen because they address the demand for commercial assets, both from the investment and tenant standpoints.

- Quarterly change in CPI: (Median Consumer Price Index: “Federal Reserve Bank of Cleveland, Median Consumer Price Index [MEDCPIM157SFRBCLE], retrieved from FRED, Federal Reserve Bank of St. Louis <https://research.stlouisfed.org/fred2/series/MEDCPIM157SFRBCLE/>, [10/22/2015].”)

- Quarterly change in 10 year bond yield: (10-Year Treasury Constant Maturity Rate: “Board of Governors of the Federal Reserve System (US), 10-Year Treasury Constant Maturity Rate [DGS10], retrieved from FRED, Federal Reserve Bank of St. Louis <https://research.stlouisfed.org/fred2/series/DGS10/>, [10/22/2015].”)
- Quarterly change in 2 year constant maturity yields: (2-Year Treasury Constant Maturity Rate: “Board of Governors of the Federal Reserve System (US), 2-Year Treasury Constant Maturity Rate [DGS2], retrieved from FRED, Federal Reserve Bank of St. Louis <https://research.stlouisfed.org/fred2/series/DGS2/>, [10/22/2015].”)
- Quarterly Consumer confidence: Surveys of Consumers, University of Michigan
- Quarterly Implied Net Operating Income growth*
- Quarterly change in white collar employment: (BLS Bureau of Labor Statistics www.bls.gov/data/)

Recall that cap rates are not included as a variable in the downturn risk model because they are used to define the downturn periods.

*The Implied Net Operating Income growth variable developed by WEF Asset Dynamics Advisory Committee member Stijn van Nieuwerburgh in support of the Early Warning Indicator is detailed below. Stijn, who is also a faculty member at NYU Stern, applied his analytical model to U.S. commercial yields and U.S. REIT return data to derive the assumptions being made around risk and return. This method combines a 5 factor model of returns and a Campbell-Shiller decomposition to answer the question, “If investors are being realistic about the risk of real estate investments, then what do the current market prices say about investor assumptions on income growth?” This method is described on the following page.

Potential Indicator	Metric	Potential Source	Horizon
Market Values	CPPI Values	Costar CCSRI	1998 - present
Rental Levels	Gross Rent Overall	Costar	1999 - present
Price to Rent Ratio	Rent per Sq. Ft.	Costar	1999 - present
Mortgage Quality: Low-Documentation	CMBS Commercial Mortgage Delinquency Rates	Trepp	1998 - present
Cost of Debt, Credit Spreads, and Swap Rates	Swap Rates	Bloomberg Terminal	1996 - present
Debt Finance from Domestic and Foreign banks	CMBS Commercial Real Estate Debt Volume	Trepp	1998 - present
Profile of Loan-to-Value Ratios by Market and Age of Loan	CMBS Loan to Value	Trepp	1998 - present
Commercial Mortgage Debt	Commercial Mortgage Originations	Trepp	1998 - present
Effective Rental Levels	Effective Rent Levels	NGKF	1999 - present
Cross-Border Investments into Real Estate	Cross-Border Investments into Real Estate	Real Capital Analytics	2000 - present
Transaction Volume	CMBS Real Estate Transaction Volume	Real Capital Analytics	2001 - present
Vacancy Rates and Take-Up Rates	Percent Vacant and Percent Absorption	Costar	1996 - present
Development Pipelines as a % of Market Size	Total RBA, Sq. Ft. Under Construction	Costar	1996 - present

Net Operating Income (NOI) Growth - Implied Assumptions Analysis

The following has been provided by Stijn van Nieuwerburgh

"Using U.S. REITs as a good proxy for the overall valuation dynamics in commercial real estate, how reasonably commercial real estate is priced in the U.S can be gauged.

Starting from a model for risk premia, or expected excess returns on REITs, a dynamic five factor model is estimated with stock, bond, value, size and momentum returns as factors. The factor risk exposures (betas) are re-estimated each month based on rolling 60-month windows. To obtain the risk premium, these betas are multiplied by the average factor return over the full sample (it is important to use as much data as possible here since average factor risk premia are notoriously hard to pin down). With the time-series of the expected excess on real estate in hand, a one month nominal interest rate is added (obtained as the average over the past 60 months) to arrive at the expected return on real estate, or cost of capital. This series is plotted in the DYNAMIC EXPECTED RETURN chart on the left. The expected return came down from 13% in mid-2009 to 10% in late 2013. This 300bps decline was entirely due to the decline in the risk-free rate.

Dynamic Expected Return



Over the most recent 18 months since then, the dynamics of the expected return are fully driven by the risk premium since the short-term nominal risk-free rate has been zero. Risk premia have been going up over this period, mostly because the stock and bond risk of real estate has increased (the size and value risk of real estate has actually decreased). With this time series of expected returns and with the time series of observed price-dividend ratios (inverse cap rates) in hand, we can ask what investors' expectations are about future dividend (NOI) growth, using the present-value model due to Campbell and Shiller (1989). At each point, it is assumed that NOI growth will be at its long-term average after year 10. What the market perception of dividend (NOI) growth must be over the next 10 years is backed out, expressed as an annual growth rate, in order to justify the current cap rate and given the current expected return from the five-factor model described above.

Expected annual dividend growth over next 10 years



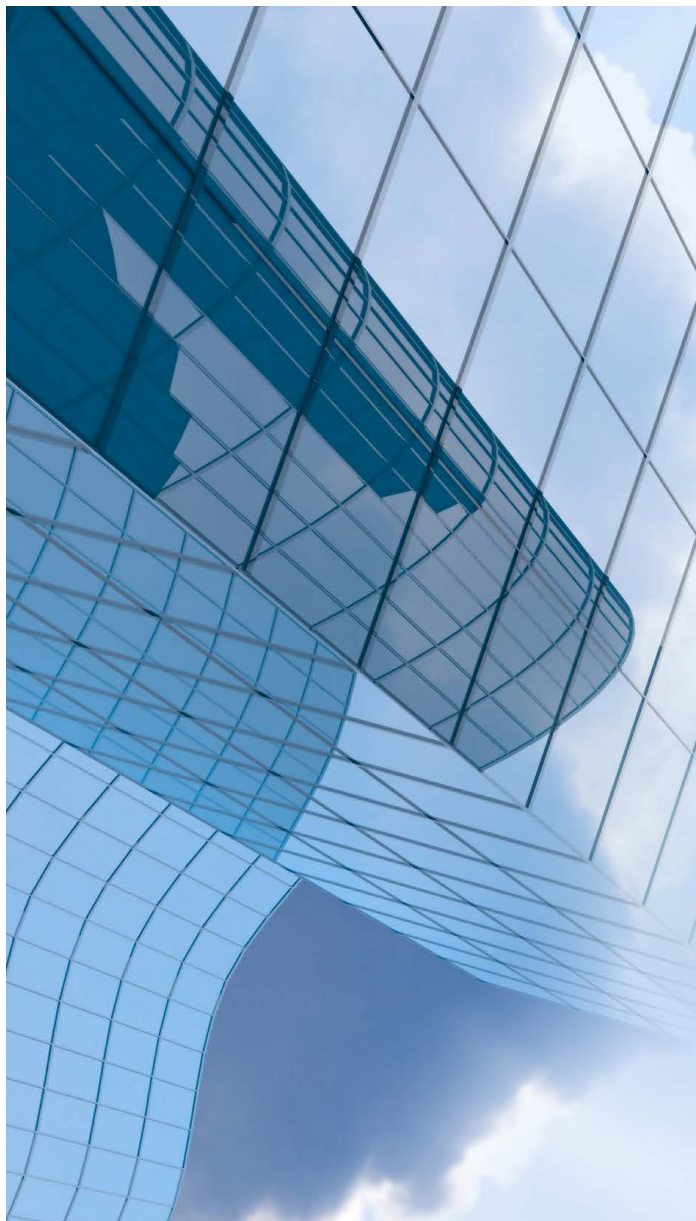
The EXPECTED ANNUAL DIVIDEND panel above gives the answer. It shows that the market currently expects dividend growth on REITs to be around 10% per year (for the next 10 years). This is not only an aggressive growth prediction in absolute terms, it is also high relative to the long-term average growth rate of 3% (solid red line) and relative to the implied growth rate over the past 30 years. The implied growth assumptions that are priced in are at the same level as they were in 2007 at the peak of the previous boom."

Key Findings

The following summarizes two other key market findings that were observed during system design and development of the Early Warning System.

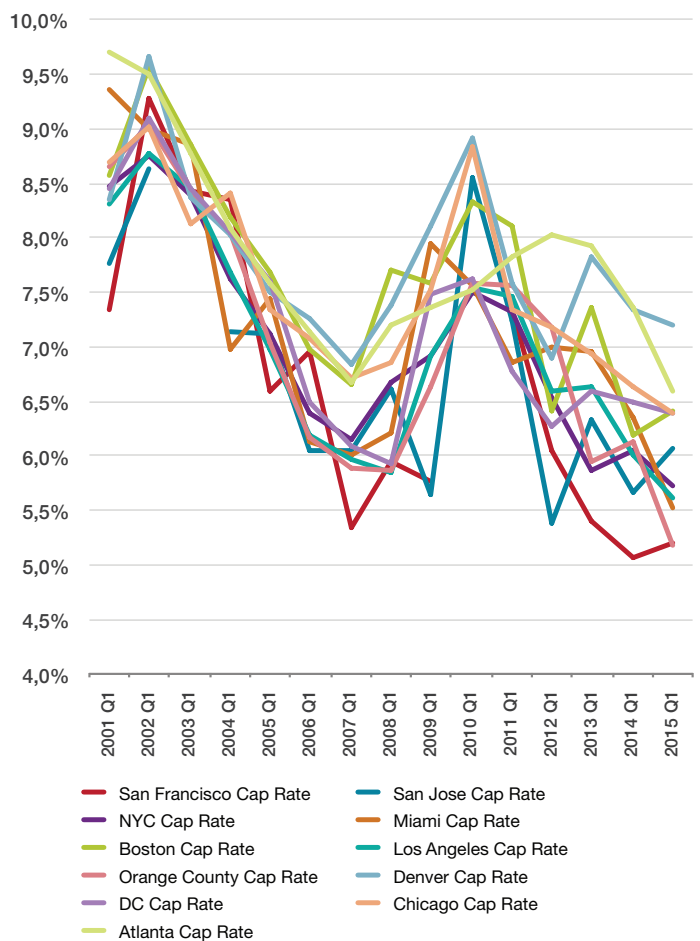
Cap Rates Track Nationally

While each local market within the United States has some unique characteristics, cities of similar sizes tend to hold similar attraction for investors: small cities draw modest investor demand, with investors concerned over lack of liquidity and smaller pool of qualified tenants for re-leasing at expiration; large cities, conversely, draw disproportionately higher investor demand with perception of increased liquidity and higher population of qualified tenants for re-leasing. As a consequence, small cities carry a risk premium over large cities which is reflected in the cap rates for these different markets. This does not mean that small cities cannot attract national or global investors; rather, those cities attract national and global investors looking for higher yield than they can otherwise achieve in larger cities. As a consequence, despite regional economic differences, major



US markets cap rates tend to move at similar times—either up or down—reflecting the national and global appetite of property investors tracking opportunities between markets. Risk premiums increase or decrease in proportion to overall market exuberance, with periods of very high investor demand helping to decrease risk premiums while periods of lower investor demand exaggerate risk premiums between markets of different sizes or global awareness. While cap rates clearly do not move in lockstep across different markets, their movements do rhyme: national/global economic events can be tracked even while risk premiums increase or decrease relative to overall investor risk appetite. See chart to the right which maps commercial cap rates. Source: Real Capital Analytics www.rcanalytics.com

Commercial Cap Rates (by Metro)



Conditions, not Time Determines the Probability of a Downturn

Time does not appear to be a determinant factor in bubble formation or subsequent market corrections. Intervals between tagged bubbles ranged from four to ten years, reflecting a convergence of conditions that have repetitively existed – but do not have to exist. The temptation to say we are “due for” a bubble or subsequent correction based solely on interval should be resisted.

Indicator Applications ●

The Indicator has a broad range of potential applications to commercial real estate investment and management and related policy making. To demonstrate how the prototype could be utilized, we have provided three case studies that demonstrate how an indicator like the one described in this paper, combined with traditional methods and metrics, could augment real estate decision making.

Portfolio Diagnostics

An investment manager is told to allocate a large capital amount to commercial office real estate. She performs an in-depth analysis of several markets, including New York and DC. The investment manager would like to choose markets with better liquidity, thus New York seems like more of a safe bet. When she looks at the downturn probabilities for both markets however, a clear difference emerges. New York has a downturn probability of 76% over the next two years, while DC is only at 43%.

She goes to her investor, and uses her data and this indicator to explain these risks. Her investor represents a pension fund, and is most interested in capital preservation. They both agree that even if DC has less liquidity than New York, they would be much better off investing in DC.

Investment Timing

A high net worth individual in Miami sees commercial values quickly rising. Currently, he has a very small portion of his portfolio allocated to real estate, having been burned in the previous market downturn. His portfolio manager is suggesting that he invest in real estate, but he is cautious. More aggressive investors, like (private equity) firms, were very quick to invest at the bottom, and achieved fantastic returns, but he does not want to be “the last one to the party”. He checks the downturn probability for Miami over the next three years, and finds the probability of a downturn over the next 3 years is only 33%.

Confident that he is not “late to the game”, and attracted by the benefit of diversification, the investor decides to allocate a significant portion of his wealth to a REIT based in Miami.

Development Decision

A property developer in San Jose is evaluating a vacant plot. The submarket in question is at historically low vacancies and major tech firms are searching for more space. The construction cost analysis reveals a healthy profit margin if the lease up period occurs in an up market. As part of the due diligence process, the developer looks at the San Jose downturn probability and finds that the probability of a downturn over the next two years (his construction timeline) is a worrying 84%.

The developer's first thought is to cancel construction, but the developer feels that this project will deliver long term value. Instead of canceling, the developer decides to get creative. The developer sets aside a fund to purchase put options on a real estate index, knowing this will not perfectly track with his asset, and then transfers the ownership of the fund to the same LLC he uses for project construction. The developer has effectively bought insurance against a downturn. This lowers the overall return slightly, but gives the developers (and –the investors) confidence that the developer will be able to pay off the construction loan.

Ability to Scale Prototype ●

The prototype was designed to be scalable and flexible. The initial focus on U.S. office assets in gateway markets was due to concerns about local market data availability, but several of the variables used by the model are major national economic indices that have rich datasets stretching back decades – at least in most developed nations. Given this, we believe that scaling this prototype to new global markets may be achievable in many instances. Scaling to other asset classes, such as Residential, may also be achievable.

Global Markets

Europe, Asia, South America and Africa represent opportunities for property investors. The high potential for growth in these markets is measured against varying degrees of transparency in data. Investors often have to rely on a local expert. These local experts give valuable insight into local market conditions, but suffer from the same lack of historical data that makes long term forecasting difficult. In many emerging markets, less than five years of real estate market historical data is the most an investor can hope for. The result can be underinvestment. An Early Warning System could provide valuable insights to these investors by either warning them of a downturn in an illiquid market, or creating confidence in the rapid growth that makes these opportunities so attractive. To apply this type of model, a long historical time series of data is preferred but not necessary. As long as a set of proxy variables for value can be found and peak periods can be estimated, the model can be deployed.

Many global markets may present different sorts of risk to investors. Let's take the example of geopolitical risk. If we find that geopolitical risk is an important consideration to property investors in emerging markets, we can take a sample of the geopolitical risk indices published by many firms and add this viewpoint to our indicator. In this manner, we believe there may be an opportunity in the future to scale the prototype methodology to address new challenges that will be encountered in emerging markets.

Residential

Residential assets present unique challenges in determining fundamentals. Far fewer residential properties are rented, especially single family homes. This makes analyzing potential income difficult, complicating valuation. At the same time, residential assets are an integral component of our economy, as was demonstrated clearly by the financial crisis. Understanding the probability of downturn can help homeowners deciding to rent or purchase, and allow them (and rating agencies, mortgage banks and other market participants) to understand the likelihood of defaulting on a mortgage.

Mortgage data are more plentiful for residential than commercial. Residential data did not play a part in our commercial asset downturn indicator, but would likely need to be included to extend the methodology to residential. Those variables that were predictive for office real estate in the sample markets may need to be tested with residential asset and markets.

Limitations ●

Our mission was to test the feasibility that the past can predict the future as it relates to commercial real estate price dynamics. In developing a prototypical “proof of concept” for an Early Warning Indicator, we believe we have addressed the feasibility of such a system. While we are encouraged by the initial outputs of the Early Warning prototype, we recognize that the robustness of a prototype cannot be compared to one in which rigorous testing and sensitivity analysis has been done.

Further, while previously stated, it must be reiterated that any Early Warning indicator is not a “silver bullet”; it does not replace conventional analysis and understanding, rather it augments it.

One limitation of the prototype model is a long time lag for additional data. Business cycles and the accompanying downturns are not everyday occurrences, so applying the prototype to future events is literally a waiting game. With use, this prototype has the potential to get more accurate over time, but for now, the initial testing suggests that the prototype describes a fundamental component of real estate markets.

One of the most interesting criticisms of this model is that this impact will change the dynamics of the asset market, which may confound the predictions of the model. For example, if the system says that the chance of a downturn in Boston is 90% over the next two years, investors may choose to avoid Boston, or sell owned assets. This could cause the market to deflate, rather than experience a crash, and thus the system will have been incorrect. This is a valid criticism, but if this were to happen, the input data should reflect this shift in market values, and the system should eventually correctly reduce the downturn probability.

A notable topic for future research will be the error structure of this hybrid model. When dealing with the prediction of time series, it is essential that the errors of the model (differences between predictions and what was observed) be independent. Without correction, this can lead to an incorrectly specified model. While correction procedures exist for probit and hazards models, and were applied, it may be that this type of model requires a different method.

Lastly, in markets where national economic indicators do not exist, an Early Warning System would be difficult to train. If investors and managers are looking for this type of indicator in those markets, hopefully this might spur policy makers to take actions to collect and distribute this data. (Schwartz & Wilde, (Spring, 1982))

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The following section describes the various markets Players and Influencers in the Commercial Real Estate Investment ecosystem that would use the Early Warning System.

III. Understanding the Underlying Investment Ecosystem

This section describes the Commercial Real Estate Investment Market Players and Influencers. It illustrates the market fragmentation and how the various participants have very different (and often conflicting) motives. This understanding is necessary to appreciate how the actions and perceptions of the market participants can contribute to and exacerbate asset bubbles and how an Early Warning Indicator could help mitigate ill effects of dramatic market downturns.

Commercial real estate (inclusive of agricultural land) is the oldest asset class, but not the most transparent or the best understood. Once dominated by wealthy individuals, this asset class is now aggressively sought by diverse investors as a primary asset. Straight forward financing has been augmented by complex financial instruments. Assets and portfolios are constantly being restructured. Real estate has shifted from a local to a global asset and when commercial real estate assets are misaligned with market fundamentals, markets can overheat and bubbles form. When the “bubble” bursts, individuals, institutions, markets and economies suffer the consequences.

To better understand and manage asset bubbles and market downturns, one must understand the underlying ecosystem. This ecosystem is comprised of market Players and Influencers. Think of the ecosystem as a building where Tenant rent payments are at the base. The more the building is occupied by tenants, the more robust the income stream and the more valuable the property. This ecosystem is graphically represented on the next page and the graphic is further described below.

The ecosystem is fueled by a variety of debt and equity investors, each with their own risk profile as represented by the Debt and Equity Tower. As one goes higher up in the tower, both the risk appetite and the expected return increases. Although there are many debt and equity investors, they often act independently of one another.

These debt and equity investors all have direct access to Investment Managers as illustrated by the elevator on the right hand side of the facade; the Investment Manager places the capital on behalf of the investors. Once the capital is placed, the Real Estate Manager is responsible for managing the property asset consistent with the goals of the investors as stated by the Investment Manager.

The market Players are supported by a cadre of market Influencers; these Influencers are represented by the Property Services Tower. In addition to the many regulatory and legislative Policy Makers that influence commercial real estate, market Influencers include Appraisers, Central Banks, Economists, the Media and more.

Throughout the life of the investment, the climate is constantly changing and each of the Players monitor their interest and investment in the building. Each Player has a different focus/perspective (income, fees, capital appreciation, use), as illustrated from their differing views from their windows and Players use different metrics to measure success and monitor operations.

Actions taken by the Players and the Influencers ripple across the entire ecosystem and the effects of many small changes are often compounded and amplified throughout the system.

Distinguishing the Market Players from the Market Influencers

Debt and Equity Players play a vital role in the ecosystem and often allocate their capital across multiple asset classes. According to Almond (2015)¹ the global real estate market is \$13.6 trillion broken down as follows:

- Private real estate debt \$6.0 trillion
- Private real estate equity \$5.1 trillion
- Public real estate equity \$1.0 trillion
- Public real estate debt \$1.5 trillion

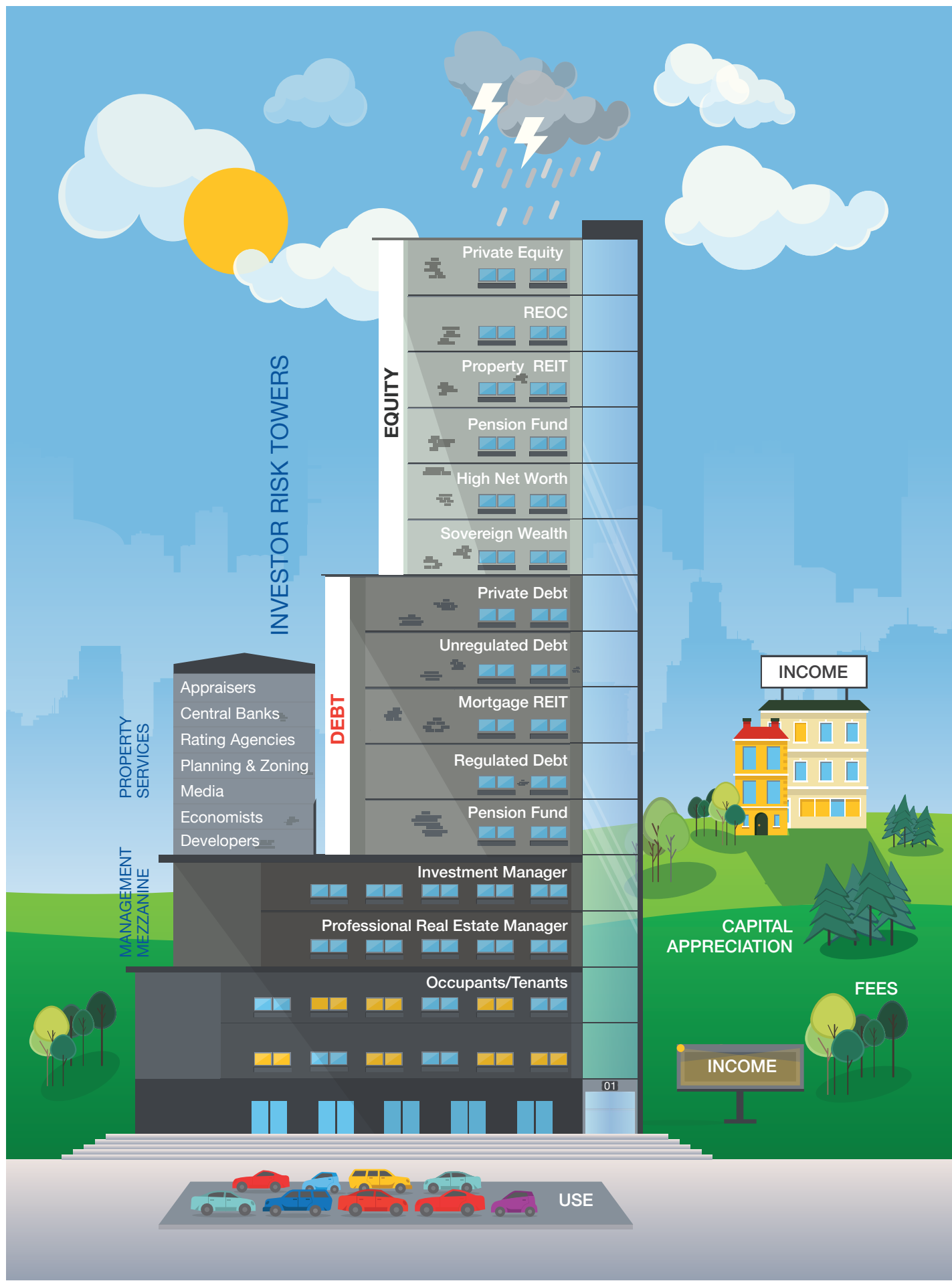
Unlike residential real estate where a property most often has one equity player (the mortgage holder) and one debt player (the mortgage bank), commercial real estate properties are often financed by multiple debt and equity players. Individual properties and portfolios are often restructured throughout the life of the asset, so the players for an individual asset often change.

Each Investor has a unique risk profile and strategy which must weather cyclical ups and down. See chart on the following page. In general, the further down the chart you go, the lower the risk threshold.

“Real estate markets have always gone through cycles and it is probably impossible to put measures in place that would smooth out all fluctuations. Moreover, it is important to consider that such measures may prompt investors to take more risk by leveraging up or undertaking riskier projects in response to the perceived stability the measures create”

Stijn van Nieuwerburgh,
WEF Asser Dynamics Advisory Committee member

COMMERCIAL REAL ESTATE INVESTMENT ECOSYSTEM



Equity Investor	Description	Example
Private Equity Fund	A private equity fund is a collective investment structure used for making investments in various equity and debt securities and/or assets according agreed to investment strategies. Private equity funds are typically limited partnerships with a fixed term of 10 years	TPG Partners, Blackstone, Fortress, Kohlberg, Kravis, Roberts (KKR)
REOC (Real Estate Operating Company)	A real estate operating company (REOC) is similar to a real estate investment trust (REIT), except that an REOC will reinvest its earnings into the business, rather than distributing them to unit holders like REITs do. REOCs can be private, public non-traded, or publically traded	Landmark Infrastructure Partners LP, Alexander's Inc.
Property REIT (Real Estate Investment Trust)	Real Estate Investment Trust (REIT) is a type of entity that invests in real estate through property or mortgages. It can be privately or publically traded. REITs distribute 90% of taxable net income. Equity REITs invest in and own properties. Public REITs can provide investors with a liquid stake in real estate	Brandywine Realty, Liberty Property Trust
Pension Fund	A fund established by an employer to facilitate and organize the investment of employees' retirement funds contributed by the employer and employees	Social Security Trust Funds (U.S.), Government Pension Investment Fund (Japan), TIAA/CREF
High Net Worth – Family Office	High Net Worth is a classification used by the financial services industry to denote an individual or a family with high net worth. Although there is no precise definition of how rich somebody must be to fit into this category, high net worth is generally quoted in terms of liquid assets over a certain figure and access to private equity funds, hedge funds, pre-IPO and IPO (initial public offering) shares, etc. There is an ability to purchase large properties or portfolios with little to no liquidity issues or need for debt financing. "Family Office" generally refers to the group charged with managing the High Net Worth individual or family	Bill Gates, Warren Buffett
Sovereign Wealth	A sovereign wealth fund (SWF) is a state-owned investment fund investing in real and financial assets such as stocks, bonds, real estate, precious metals, or in alternative investments such as private equity fund or hedge funds. Sovereign wealth funds invest globally.	China Investment Corporation (CIC), Kuwait Investment Authority (KIA), Abu Dhabi Investment Authority (ADIA)
Debt Investor	Description	Example
Private Debt	Private debt is issued by private companies when they borrow using simple loans in order to raise funds for expansion or operations	AEA Investors, Golding Capital Partners
Unregulated Debt	The financial intermediaries involved in facilitating the creation of credit across the financial system that are not subject to regulatory oversight. Also known as "shadow" banks. The shadow banking system can also refer to unregulated activities by regulated institutions. Unregulated debt can include Insurance Companies that provide debt for stabilized real estate investments in order to generate income to cover annuity payments from annuity buyers	AIG, State Farm
Mortgage REIT (Real Estate Investment Trust)	Real Estate Investment Trust (REIT) is a type of entity that invests in real estate through property or mortgages. It can be privately or publically traded. REITs distribute 90% of taxable net income. Public REITs can provide investors with a liquid stake in real estate	Pimco Commercial Securities Trust, Starwood Financial Trust
Regulated Debt (e.g. Commercial Bank)	Regulated debt covers a broad spectrum of organizations where there are regulatory laws and guidelines associated with investing practices and procedures. A commercial bank is one of several institutions that fall under this broad category. A commercial bank often specializes in originating and/or servicing commercial property mortgage loans.	Chase, Bank of America
Pension Fund	A fund established by an employer to facilitate and organize the investment of employees' retirement funds contributed by the employer and employees	Social Security Trust Funds (US), Government Pension Investment Fund (Japan)

Once the allocation strategy has been determined, the capital is often placed by an Investment Manager. As the ecosystem graphic illustrates, the Equity and Debt Investors have direct access to the Investment Manager (through the elevator), but the individual investors often have limited contact with each other. It is up to the Investment Manager to match the different strategic objectives of the various investors to various commercial real estate assets and portfolios.

"I know that investors are doing their homework. They are looking at doing their own analyses on things and it's what they should be doing, but of course we know that they have these pressures concerning taking care of their portfolio"

WEF Asset Dynamics Steering/Advisory Committee member

As we transition from Investors, to Investment Managers and Professional Real Estate Managers, the focus changes; while Investors focus primarily on Capital Appreciation and then Income, Investment Managers and Professional Real Estate Managers focus predominantly on Fees and Income.

Other Key Players	Description	Example
Investment Managers	Investment managers decide how to allocate money to a variety of investment and asset types based on investment strategies. Investment Managers that invest in real estate seek to maximize the performance and value of a portfolio of real estate assets	BlackRock, The Blackstone Group
Professional Real Estate Manager	Professional Real Estate Managers are advisors that manage real estate assets consistent with agreed to performance and value objectives. Professional Real Estate Managers are often concerned with increasing the operational utility of individual assets through increasing occupancy	Newmark Grubb Knight Frank, Brookfield, SL Green Realty Group, JLL, CBRE

Conversely, Tenants most often view real estate as a factor of production, not as an investment – while Tenants are encouraged to pay competitive prices, they are often more focused on the use and utility of the space being rented.

The following chart shows that the focus is different for different Market Players. It is understandable that a different focus would result in a different set of Key Performance Indicators (KPIs) - but it is interesting to note that even when the focus is similar, as in the case of Equity Players, the KPIs used may vary reflecting very different strategies and motivations. This variability in KPIs is illustrated in the chart below.

For example, while many feel the only difference between a REOC (Real Estate Operating Company) and a REIT (Real Estate Investment Trust) is the legal entity structure, you can see from the above that while both the REOC and the Property REIT measure EBITDA/GAV (Earnings Before Income, Taxes, Depreciation and Amortization/Gross Asset Value), public REOCs are more inclined to measure TRB (Total Return to Shareholders) and ROIC (Return on Investment Capital) and REITs are more likely to measure FFO (Funds from Operations), Share Price, and Dividend Yield.

		FOCUS					KPIs																										
		Capital Preservation	Capital Appreciation	Income	Fees	Use	Internal Rate of Return (IRR)	Multiple on Invested Capital	2 and/or 20	Total Return to Shareholders (TRS)	Return on Invested Capital (ROIC)	Earnings Before Interest, Taxes, Dep and Amortization/Gross Asset Value (EBITDA/GAV)	Funds from Operations (FFO)	Share Price	Dividend Yield	Yields	Credit Spreads	Net Operating Income (NOI)	Portfolio Growth	Portfolio Diversification	Debt Service Coverage (DSC)	Debt Service Coverage Ratio (DSCR)	Loan to Value (LTV)	FFO/Share Price	Quality of Guarantees?	Transaction Volume	Assets Under Management (AUM)	Vacancy and Utilization	Net Effective Rent	SF or SM/Person	Favorability of Contract		
Equity Investor	Private Equity Fund	✓	✓				✓	✓	✓																								
	REOC		✓	✓						✓	✓	✓																					
	Property REIT		✓	✓								✓	✓	✓	✓																		
	Pension Fund	✓	✓										✓				✓																
	High Net Worth - Family Office 1st Gen		✓	✓														✓	✓	✓													
	Succeeding Generations		✓	✓														✓	✓	✓													
	Sovereign Wealth		✓	✓													✓			✓	✓												
Debt investor	Private Debt		✓	✓												✓	✓				✓		✓										
	Unregulated Debt		✓	✓												✓	✓				✓		✓										
	Mortgage REIT			✓																	✓		✓	✓									
	Regulated Debt		✓	✓												✓	✓					✓	✓		✓								
	Pension Fund			✓												✓																	
Mgmt	Investment Manager		✓	✓	✓													✓									✓	✓					
	Professional RE Manager			✓	✓													✓									✓	✓					
	Occupant/Tenant					✓																							✓	✓	✓	✓	

Note: "2 and 20" refers to a management fee of 2% of assets under management and 20% of profits

While the KPIs for the Debt Investors are more consistent, there is still some variation. Yields, Credit spreads, and LTV (Loan to Value) dominate the Debt KPIs, but it is worth noting that Yields are the singular most important measure for Pension Funds, reflecting their focus on Income.

It is also worth noting that while their focus is a bit different, the primary KPIs for Investment Managers and Professional Real Estate Managers are the same and dominated by 2 volume measures – Assets Under Management (AUM) and Transaction Volume and one asset related KPI – Net Operating Income (NOI). Of all of the market Players, the Tenants seem to have a balanced scorecard approach to KPIs where a financial metric (NER Net Effective Rent) is balanced by Operational and Client related metrics.

Collectively, the market Players in conjunction with the Influencers are the core of the ecosystem and their relationships to one another form a network where information, money, and ideas are exchanged.

There are many regulatory and legislative Policy Makers that impact the commercial real estate ecosystem and these vary widely from country to country. In addition to these Policy Makers, there are many other market Influencers support the Players throughout the asset and business life cycles. In the ecosystem graphic, these Influencers are represented by the Building Services Tower because they are critical to operations. Influencers usually have specialized knowledge and are most often certified and accredited in their field. Selected Influencers and their typical KPIs are summarized below.

Influencers	Description	KPIs	Example
Appraisers	Company or institution that performs property valuation for a third party. Often done by researching historical market transactions to approximate current market values	– Transaction Volume	Butler Burgher Group, Valbridge Property Advisors
Central Banks	A central bank, reserve bank, or monetary authority is an institution that manages a state's currency, money supply, and interest rates. The Federal Reserve System (also known as the Federal Reserve, and informally as the Fed) is the central banking system of the United States	– Inflation – Unemployment and Underemployment – Systemic Risk – GDP (Gross Domestic Product)	Federal Reserve (US)
Rating Agencies	A credit rating agency is a company that assigns credit ratings, which rate a debtor's ability to pay back debt by making timely interest payments and the likelihood of default	– Transaction Volume	Moody's, Standard & Poor's, Fitch
Municipal/ Urban Planning & Zoning	Responsible for setting and maintaining the framework of city's physical and socioeconomic planning, including urban planning and zoning as the city evolves over time	– Changes in Migration Patterns – % Adoption of New Construction Techniques – Actual Growth/Planned Growth – Code Compliance	New York City Department of City Planning
Media	The means of communication, as radio and television, newspapers, and magazines that reach or influence people widely.	– Page Views – Website Hits	New York Times, Bloomberg
Economists / Academics	An expert who studies the relationship between a society's resources and its production or output	– Number of Published Articles/Books – Panel Participation – Number of Media References	Robert Shiller, Nouriel Roubini, David Geltner, Colin Lizieri
Real Estate Developers	Create, imagine, control and orchestrate the process of real estate development (and redevelopment) from the beginning to end. A developer often buys the land through a combination of debt and equity and is therefore often a property owner/investor – however a developer can also offer individual a-la-carte services for specific projects	– Schedule and Cost Variance – Margin - if an owner/investor – IRR (Internal Rate of Return) - if an owner/investor	Boston Properties

Incentives and Principal-Agency Issues

In reviewing the KPIs for both Players and Influencers, you may notice that many ecosystem participants (both Players and Influencers) may be motivated by transaction size and volumes. When the incentives of an agent are not aligned with the incentives of the principal(s) they serve, a principal-agent issue is said to exist. When agents are paid based on transaction size and volume, they may be motivated to pursue transactions that may not be in the best interest of the investor (principal) they serve. This misalignment of interests and incentives could potentially result in transactions that are not supported by market fundamentals.

Ripple Effect

Since commercial real estate assets are very heterogeneous, it is very difficult to make discrete, attribute based assessments and there is a heavy reliance on “comparables”. This heavy reliance on reference data creates an environment where an independent, yet potentially biased or irrational appraisal valuation or transaction could echo and reverberate throughout the ecosystem with a compounding effect because the original transactional information is used over and over again.

“When the market was transparent and legitimate and underwritten properly, people who create value and know the real estate business prevail. When the market is a false market, the financial engineers take over”

Barry Gosin, CEO of Newmark Grubb Knight Frank and Project Champion for WEF Asset Dynamics Early Warning System

How the Ecosystem Can Shift – e.g. Sovereign Wealth’s Impact

Commercial real estate transactions used to be fairly straight forward. Capital was often a combination of equity and debt and the property was the collateral. As commercial real estate matured as an asset class, more investors got involved and commercial real estate shifted from a local to a national to a global asset class. Financial instruments became more sophisticated as both properties and loans were bundled.

Commercial real estate will continue to mature as an asset class and the ecosystem will continue to evolve. These challenges can ultimately shift the entire ecosystem and even question market fundamentals.

Sovereign Wealth’s impact on the ecosystem is well described in the following reprint of a WEF blog entry from December 2015 by Colin Lizieri. Colin Lizieri is a member of the WEF Asset Dynamics Advisory Committee, author of *Towers of Capital*, and Grosvenor Professor of Real Estate Finance at the University of Cambridge.

“The globalisation of real estate investment has introduced new players into property markets, investors who may have very different characteristics from the traditional players. Major global real estate investors face lower portfolio risk because they have diversified away much of the domestic risk in their portfolios; they have access to cheaper sources of capital, both debt and equity and, hence, have lower costs of funds. Their reference risk free rate is a global rate or what prevails in their country of origin, not the local bond rate. As a result, when global real estate investors invest outside their home country, their required returns may be lower, sufficiently low to more than offset their information disadvantages and higher search costs compared to local investors. Furthermore, where those investors have long time horizons or are not subject to short run market pressures to realise capital – for example, the sovereign wealth funds – then they do not have the same requirement for the liquidity premium that finite life funds and firms require.

As such investors increase as a share of market participants, as the buyer setting prices in the market becomes a well capitalised, non-domestic investor, then cap rates might be influenced downwards, reflected higher asset prices. The City of London again provides an illustration: the University of Cambridge’s latest Who Owns the City research suggests that nearly two thirds of office space in the City is held by non-domestic investors, who also dominate ownership of newly developed space in the market. If this has resulted in a downward movement in yields, then it should raise questions about the expected returns and risks for investors without those long run global characteristics. There is also a risk that (possibly rational) lower yields in such globalised markets influence falling yields in other markets which do not have the same characteristics – artificially inflating prices.

*One other implication of this global trend is that investment is increasingly concentrated in a small set of cities that offer substantial high value assets for investors with a need to place vast amounts of capital quickly and without distorting the market. These major cities offer scale economies and are served by global service providers. Real Capital Analytics data for major office transactions in the period 2007-2014 showed that over 50% of investment by value went to just ten cities, over 75% to the top 25 ranked cities. Furthermore, the head-quarters of the owners of that real estate are predominantly located in those same cities, which are also home to the providers of debt and equity for the investors. This emphasises the locking together of investment, occupational and financial interests in office markets in major cities that I set out in *Towers of Capital* and raises questions about exposure to systemic risk and the contagion effects of capital market shocks propagating across globalised real estate markets. Much of the justification for holding a global real estate portfolio comes from diversification benefits: but if the funds allocated to real estate are increasingly concentrated in markets with the same economic drivers, those diversification effects may be dissipated. In effect, in the risk premium, systemic risk exposure to global shocks could offset the gains from diversification and liquidity.”*

Endnotes

1. Almond, N., 2015, Money into property 2015, Technical report, DTZ Research.

IV. Operating Metrics – Myriad And Myopia

This section highlights the myriad of operations metrics used in the CRE ecosystem and recognizes cap rates as a universal metric.

Overview of Operating Metrics ■

In addition to having different strategic objectives (reflected in different KPIs), members of the eco system also use different operating indicators and metrics. Market Players all use a combination of macro- economic metrics, to real estate industry metrics, and property specific metrics - but in varying degrees. See chart below.

Similar to the variation in KPIs, note the high degree of variation among equity investors on the operating metrics; conversely, there is a high degree of indicator convergence among debt players. While the KPIs for Investment Managers and Professional Real Estate Managers were virtually the same, this chart illustrates that Investment Managers uses a cross section of macro-economic, real estate market and property indicators, but the Professional Real Estate Manager concentrates more on real estate market indicators.

One could argue that the above referenced myriad of multiple operating metrics spanning macro-economic, to industry, to property level are a symptom and signal of a very fragmented market full of specialists and special interests. The concept of fragmentation and the “perils of expertise” (ENDNOTE 2) can be applied here. However, despite functional fragmentation, there is one metric that appears to have universal appeal and utility throughout the entire commercial real estate investment ecosystem – the ubiquitous capitalization rate (or “cap rate”).

As previously mentioned, “cap rates” are considered a universal metric used by a variety of market players. The cap rate is a single-period value metric which describes pricing as a function of the first year’s unlevered yield. The cap rate does not explicitly address multi-period factors involving contract rent changes over time, residual value risk at expiration of rental contract, or collection risk during contract terms. Rather, it is used as a simple market metric to compare yields of different trading assets—both within and between different markets. Cap rates are widely used by Investors, Brokers, Analysts, and Managers alike.

		Macro-Economic														Industry Level										Asset Level										
		Yield Curve and Spreads	Credit Spreads	Interest Rates	10 Year Treasury Bill	Shiller Price/Earnings	Savings/Gross Domestic Product	Macro Market Data	% Wealth Owned by Top 1%	Swap Rates	London Interbank Offer Rate	White Collar Employment	Country Specific Macro Indicators	Cross Border Investments in Real Estate	Dow Jones Industrial Average	Industry Profitability	Corporate Profitability	Share Price	Rents and Yield Cycles	CMBS LTV	CMBS Default Rate	CMBS Debt Volume	Property Market Indexes	Market Rental/Lease Rates	Market Occupancy and Vacancy	Take Up Rates	Building Vacancy	Property Valuations	Discount (Premium)to Net Asset Value	EBITDA/GAV	FFO/NAV	LTV	Interest Coverage Ratio	Debt Service Coverage Ration	Change in Net Effective Rent	Rent and Property Yield Data
Equity Investor	Private Equity	✓	✓																✓		✓															
	REITand REOC					✓																✓							✓	✓	✓	✓	✓	✓		
	Pension Fund (Equity)		✓	✓			✓																✓													
	High Net Worth - Family Office								✓																											
	Soveriegn Wealth												✓	✓																						
Debt Investor	Private Debt		✓		✓															✓	✓	✓														
	Unregulated Debt	✓	✓																	✓	✓	✓														
	Mortgage REIT	✓	✓																	✓		✓														
	Regulated Debt				✓					✓	✓													✓												
	Pension Fund (Debt)	✓	✓				✓																													
Mgmt	Investment Manager	✓		✓		✓																		✓	✓		✓								✓	✓
	Professional RE Manager	✓																✓						✓	✓	✓	✓								✓	✓
	Tenant	✓										✓			✓	✓	✓	✓						✓	✓		✓								✓	✓

The cap rate is expressed in different ways, with the following being often used:

CapRate = Net Operating Income/Asset Value

$E[r] = r_f + B(\bar{r}_m - r_f)$

$E[r] = \text{CapRate} + g$

$\text{CapRate} = r_f + B(\bar{r}_m - r_p) - g$

$E[r]$ - Expected Return
 r_f - Risk Free
 g - Growth
 r_p - Premium

Cap Rate Discussion ▲

While widely utilized and referenced, cap rates are not necessarily clearly understood or consistently applied throughout the ecosystem. It is however well described in the following reprint of a WEF blog entry from December 2015 by Colin Lizieri, Grosvenor Professor of Real Estate Finance University of Cambridge.

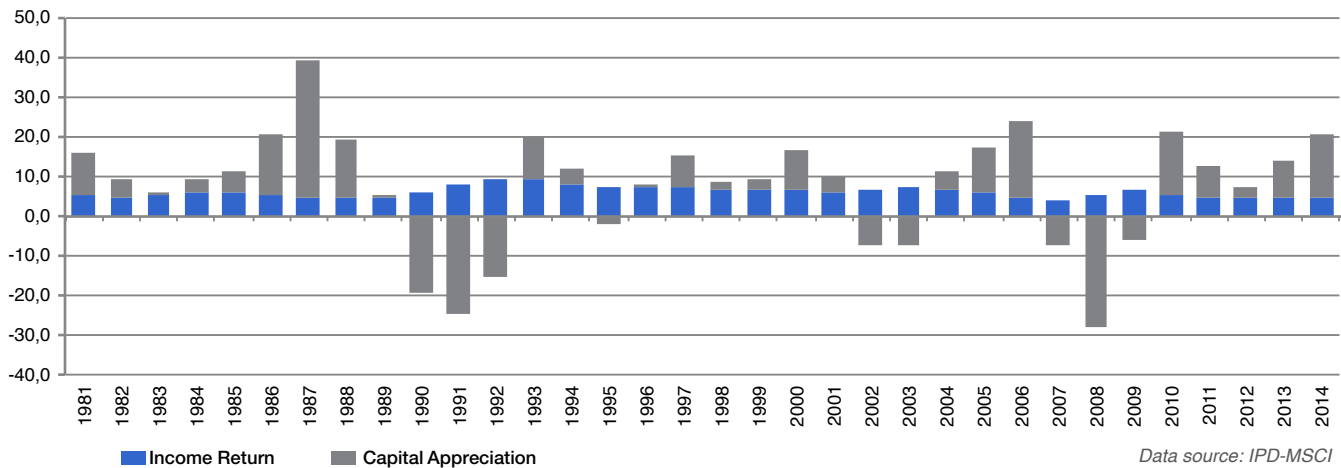
“One of the key metrics in commercial real estate investment is the yield or cap rate (capitalization rate); at its simplest, the ratio of the rent paid by the tenant to the price paid for a building (or, sometimes, the appraised value of a building held for investment). The cap rate is one of the most important indicators of the current state of the market. Cap rates are inversely related to value; as cap rates compress, perceived value goes up; falling prices imply increasing cap rates. Decreases in yields (cap rates) may be an important early warning sign that a market is overheating – particularly if cap rates diverge from sensible fundamentals. Most of all, when market participants start claiming that low cap rates

result from “a new paradigm” or a “significant change in the dynamics of the market”, it’s probably time to sell up and run for the hills! But given that yields are one of the few statistics that are routinely and regularly observed in markets, it seems odd that many participants seem to accept yield shifts as natural rather than as a source for concern.

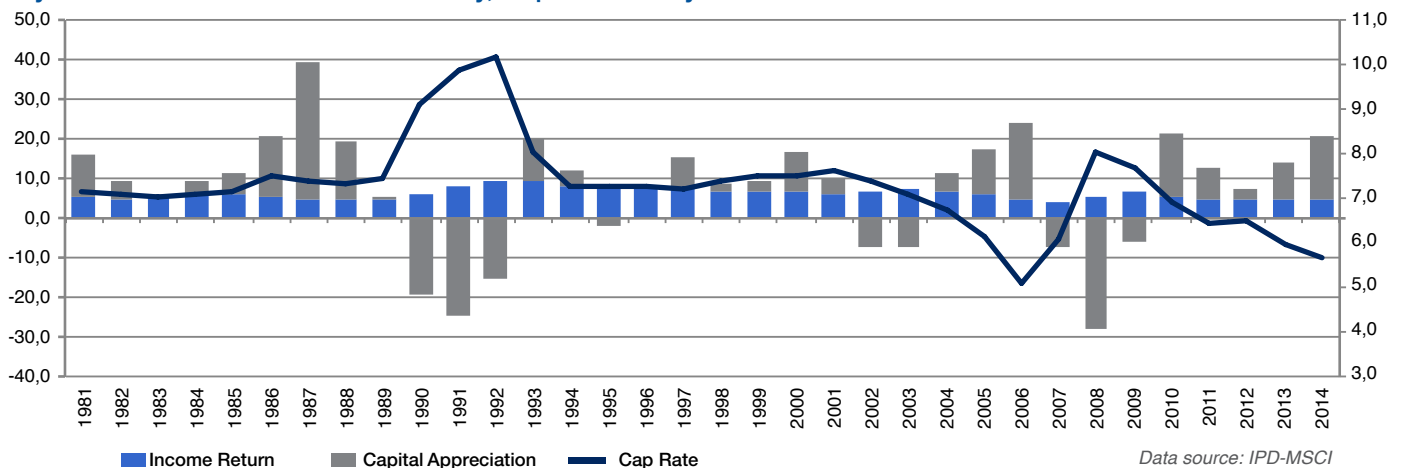
Separating out real estate returns into rental income and capital appreciation components, it is evident that the income return is remarkably stable over time in most markets. Capital growth – and more significantly capital declines – drive asset value volatility. As an illustration, IPD-MSCI data show that the annual net rental income return of City of London offices ranged from 4.1% and 9.5% between 1981 and 2014, with a standard deviation of just 1.3%. By contrast, capital appreciation ranged from -28% to +34% over the same period with a standard deviation of 13% (see the chart to the right). Capital value changes are, in large measure, dominated by changes in the cap rate. The rising prices and values before the financial crisis were driven not by rental growth but by cap rate (yield) compression; the same was true in the sharp market correction that followed, rising yields dominating rental falls. This echoes findings by Bob Shiller in equity markets, where earnings remain relatively stable over time; changes in the price-earnings ratio are driven more by price changes than shifts in earnings.

We can also interpret the cap rate as simply the outcome of supply and demand in the property investment market. If there is an excess of capital trying to get into a market relative to the investment opportunities available, prices will be forced upwards and cap rates will be forced down because investment demand exceeds supply.

City of London Offices: Income Stability, Capital Volatility



City of London Offices: Income Stability, Capital Volatility



Now, what financial theory tells us – and what we tell our students – is that the cap rate should be the required return on real estate less the long run growth in rental income (adjusted for depreciation). The required return reflects interest rates in the economy, the investors' cost of capital and their attitudes to risk. In turn, the required return in the market should be the risk free return plus a risk premium appropriate to the riskiness of the type of asset:

$$k = RFR + RP - g$$

So, if we observe yields changing in a market, that should imply that one of those components – the risk free rate, the risk premium or the long run rental growth – has changed. If we cannot see what is driving the change at a fundamental level, it may well imply mispricing in the market.

It was a common experience for both practitioners and academics in the market in 2005 and 2006 that transaction prices “did not make sense”. Putting plausible assumptions of income, growth, costs and required returns into cashflow models resulted in investment values far below achieved prices. It is at this point that behavioural factors can kick in, growth rates are increased, required returns are reduced, exit yields cut to “make” the investment appraisal fit the price and the “new paradigm” arguments emerge to back those changing assumptions. Did this make sense then? Does it make sense now?

For the risk free return, most finance texts point to government bond yields but this is only a proxy measure (in the current economic environment with suppressed redemption yields, Government bonds in many countries seem more like a return-free risk!). For a substantial period in advance of the global financial crisis, bond yields in the developed economies had been falling. Lower bond yields imply lower required returns for real estate – but not necessarily lower cap rates. The fall in bond yields was largely due to lower expectations of inflation: but, to the extent that rental values hedge inflation, this should have reduced long run rental growth expectations, too. In broad measure, inflation cancels out. So for a fall in cap rates to be linked to a fall in bond yields, the real risk free rate (ignoring inflation expectations) must fall – that is, investors in general have to have become less risk averse. There was a general view that that was true in the first half of the 2000s: a belief that (international) macro-economic management had reduced cyclical instability as well as inflation, feeding through into lower required returns on investment. Whatever the outcome, it was not completely irrational to hold such views, despite subsequent rewriting of history.

In the current market environment, it is more complicated to analyse the linkage between the very low government bond yields (suppressed by quantitative easing and other fiscal measures in the attempt to stabilise the financial system and generate some, any, economic growth) and cap rates. Admittedly, low bond rates feed into low interest rates, reducing the cost of capital for leveraged investors. But does this justify sharply lower cap rates, while maintaining “normal” expectations of real estate returns based on historic averages? In the two main economic scenarios, either bond yields will revert to long run (real) norms, increasing exit yields and damaging returns for any investors who have bought at low cap rates; or they will remain low due to continued poor economic performance and austerity programmes, implying lower returns over sustained periods. In either case, lowering cap rates to match suppressed bond yields is inconsistent with an assumption that real estate will deliver typical historic average long run property returns.

Cap rates would rationally fall (and values would go up) if expectations of rental growth increased. But there is much misunderstanding of this point: the growth component here is long run rental growth not short run increases in rents, particularly if these are cyclical. However, here behavioural factors and beliefs may play a role in reducing cap rates and driving up prices. For example, it is often observed that the rental levels, the rents per square metre, of major global cities are higher than those of smaller cities down the urban hierarchy. However, this does not mean that the rental increases of existing buildings necessarily increase at a faster rate. Much of the economic growth in cities does not translate into long term rental growth because supply adjusts, albeit with substantial lags. New stock may capture the uplift in rental values. Land values increase in response to growing economic strength: cities become denser to accommodate the growth in demand but for an existing property owner, that may require redevelopment of the existing building to increase the size and/or to modernize the space offered to capture the increased land value as a rental income stream.

The City of London again provides an illustration of this. Over the 1981-2014 shown, stock of space has increased broadly in line with the increase in employment and rental growth has been dampened by major office developments on the fringes of the City as in Docklands. From 1981 to 2014, rental value growth was around 2% per annum before inflation, -1.7% after inflation. This is consistent with long run evidence: Steven Devaney's doctoral research showed virtually no real rental growth in London offices from 1850-1950 as the City emerged as a major financial centre: long run research in New York, Amsterdam and other markets find remarkably similar results. The implication is that to capture real economic growth, an investment needs to be actively managed and held for long enough for the option to redevelop the building to become profitable. For such long term investors, acquisition of real estate in developed markets at low yields, at cap rates below long run averages may thus be rational because, over time, they pay off. But can they be rational for core, passive investors, particularly those with shorter investment horizons, finite life funds or leveraged investors with a financing constraint?

So is the cap rate the best early warning indicator of market overheating, the canary in the coalmine?

Probably not of itself: structural changes to markets and the characteristics of investors can lead to rational shifts in the yield. But it is a very important indicator, nonetheless. Investors, analysts and regulators, observing cap rate shifts need to ask what is driving that change and to analyse the fundamental components of the cap rate. Is there any reason to assume there has been a structural and sustainable change in the (real) risk free rate? Why would the risk premium have changed? Is there any reason to think that long run real rental growth will be higher in the future (remembering that supply will adjust to demand)? Have the characteristics of investors in the market permanently changed such that required returns have altered? If none of those hold, then buyer beware.”

The Early Warning prototype presented in Section 2 is not intended to replace the cap rate or the various operating metrics presented in this section. Rather, the intention is that an Early Warning System would be used in conjunction the metrics described in this section.

V. Conclusion •

“Real estate is an incredibly shackled market and the fact that people are able to value private companies more easily than buildings I’ve yet to figure it out. It just doesn’t make any sense”

WEF Asset Dynamics Steering/Advisory Committee member

While many consider the U.S. commercial real estate market to be both mature and sophisticated, the data and transparency required for consistent, defensible market-driven valuations continues to elude even the most experienced practitioners and investors. Property market valuations are challenged by the devilishly complicated mix of heterogeneous assets, fragmentation, conflicts of interests, diverse metrics and an increasingly global investor pool. Understanding value and associated risk is not impossible, however, by combining data with tried and true analytical techniques, value can be understood and quantified while associated risk can be minimized.

The Early Warning prototype described in this paper seeks to mitigate risk and understand value, but it does not represent the end of this line of inquiry - it is instead the beginning of a more quantitative approach to real estate investment. As the commercial real estate industry transitions from “no data” to “big data”, investment decisions can become more deliberate and more consistent with market conditions. Cycles will continue to exist, but an Early Warning System could potentially help stakeholders manage the extremes and moderate overall cyclicalities.

Contrarian investors—investors typically characterized by focus on anticipated future market movements rather than prior events—have often been richly rewarded and lauded for their “prescience” or ability to see into the future. In presenting the Early Warning prototype, our goal is not to eliminate the entrepreneurial incentive of market prescience. Rather, it is to recognize the opportunity to increase transparency to market premiums and moderate market corrections to better manage risk. Potential investors would still retain the ability to anticipate market movements. But in increasing overall market transparency, the destabilizing effects of capital movement rushing into and out of property markets during periods of rapid growth and rapid decline could potentially be moderated. By understanding market risk and its impact on asset values, investors may be encouraged to take smart risks, potentially increasing the pool of investors and spurring further investment in commercial real estate.

Over time, additional data and transparency across global markets will enable more precise segmentation within the commercial real estate industry. Enhanced segmentation will support more sound comparative analysis while preserving diversification opportunities within this asset class. Finer distinctions within the asset class also open the door to more advanced hedging techniques and options found in more mature (and transparent) asset classes.

While an Early Warning System could potentially enhance decision making and level the playing field across a broadening investor base over time, it cannot fundamentally change human behavior. A competitive spirit, greed, fear, status, herding behavior and many other intrinsic factors will continue to influence investment perceptions and behaviors – no matter how much data and information is available. Despite the human condition, the Early Warning System prototype and methodology presented in this paper has the potential to help create value for tenants, investors, market managers, policy makers and regular individuals through contributing to a more transparent property market. In this way, the participants in the CRE ecosystem can collectively help mitigate the ill effects of CRE “bubbles”. Whether market makers and influencers are willing to embrace this breakthrough methodology remains to be seen.

Endnotes

1. Tett, G (September 2015), The Silo Effect. The Peril of Expertise and the Promise of Breaking Down Barriers

Appendix 1: Indexing (back-casting) ▪

Purpose:

Estimate a long run time series of asset values that can be used to identify peaks in commercial real estate prices.

Background:

Business cycles and their accompanying peaks and downturns unfold over the course of several years. Any model that attempts to address distinguishing features of these cycles must do so over a suitably long time frame. This exercise requires a long run time series of commercial real estate values. Commercial cap rates are the most relevant metric for this particular exercise, and are available from several sources, each with unique -characteristics. For our specific purposes, the most appropriate cap rates are transactional, based on market values at the time of sale. Given the relative infrequency of commercial transactions, this data is subject to both noise and lag. High quality commercial cap rates are estimated by Real Capital Analytics, but this data is only available back to 2000. Appraisal based cap rates are available more with much more history and less noise, but are subject to the biases inherent in appraisals. To estimate a long run time series for commercial transaction cap rates, we created a methodology to systematically – adjust for these biases.

Methodology:

The relationship between appraisal based cap rates and transaction cap rates is market dependent. Though they broadly follow the same trend, the appraisal based cap rates are less affected by market cycles. In 2010 for instance, based on data from NRIEF it can be determined there was a 16% difference in value between appraisal based cap rates and actual transaction cap rates. The methodology attempts to - reconcile these difference by adding adjustments that track with the current business conditions.

The back-casting model uses the following independent variables to estimate local transaction cap rates:

- Local appraisal based cap rates (NCREIF National Council of Real Estate Investment Fiduciaries www.ncreif.org)
- National appraisal based cap rates (NCREIF National Council of Real Estate Investment Fiduciaries www.ncreif.org)
- 10 year constant maturity treasury yields minus 2 year treasury yields (10-Year Treasury Constant Maturity Minus 2-Year Treasury Constant Maturity: “Federal Reserve Bank of St. Louis, 10-Year Treasury Constant Maturity Minus 2-Year Treasury Constant Maturity [T10Y2Y], retrieved from FRED, Federal Reserve Bank of St. Louis <https://research.stlouisfed.org/fred2/series/T10Y2Y/>, [10/22/2015].”)
- 2 year constant maturity yields (2-Year Treasury Constant Maturity Rate: “Board of Governors of the Federal Reserve System (US), 2-Year Treasury Constant Maturity Rate [DGS2], retrieved from FRED, Federal Reserve Bank of St. Louis <https://research.stlouisfed.org/fred2/series/DGS2/>, [10/22/2015].”)

Results

On all ten markets, this model achieves an r^2 of over 85%, with all variables significant and of the expected sign. The results for New York City are shown below as an example:

The results also agree with the limited transactional data available during these periods. These results suggest that this method produces a sufficient estimate of value for the peak tagging process.

Linear regression

Number of obs	=	58
F(4, 53)	=	159,18
Prob > F	=	0,00000
R-squared	=	0,90360
Root MSE	=	0,00298

NYC_Metro_Comercial	Coef.	Robust Std. Err.	t	P> t		[95% Conf. Intervall]
NYC_Cap	-0,0862452	0,0399711	-2,16	0,0360	-0,1664171	-0,0060733
National_Appraisal_Cap	0,7485049	0,0533066	14,04	0,0000	0,6415854	0,8554244
Yield10Yr2YrSpread	0,0034679	0,0009441	3,67	0,0010	0,0015742	0,0053616
Yield2YrConstMat	0,0018494	0,0005115	3,62	0,0010	0,0008234	0,0028754
_cons	0,0163420	0,0030868	5,29	0,0000	0,0101228	0,0225056

Appendix 2: Peak Tagging (Draw-Down) ■

Purpose:

Identify periods that mark the start of major downturns in commercial values. Referred to here as “peaks”.

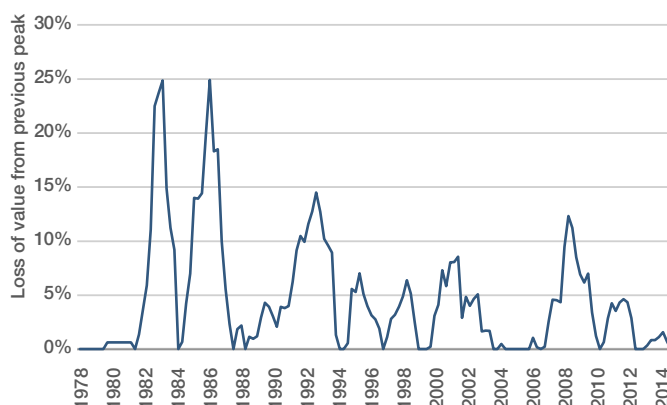
Background:

To forecast downturns, it is vital that we come to a quantitative definition of downturns. This definition should – align with market participants’ view of market cycles. In addition, the method should be robust to the choice of parameters. The method of drawdown was chosen to tag commercial peaks. To evaluate the risks of trading strategies, traders often employ this calculation. This measures the percentage difference between the current value of a portfolio versus the all-time highest value of that portfolio. This measure, distinct from volatility, allows traders to understand the vulnerability to prolonged periods of losses. A modification of this technique was used to tag commercial real estate downturns.

Methodology:

Taking the estimated commercial transaction cap rates from the back casting methodology (described in Appendix 1), ten year U.S. treasury yields were then subtracted. The resulting value is often referred to as cap rate spreads, commonly used to understand the risk and return expectations of commercial real estate. This – adjusts for the long run decrease in commercial cap rates, largely coincident with a similar reduction in treasury yields. To tag a peak first we tag “damage periods”. We define a damage period as a point where commercial cap rate spreads increase more than 20% percent from minimum values over two years. Because we have to adjust the data upwards to remove the negative cap rate spreads that occur due to high inflation, we look for 6% drops in this transformed series, which is equivalent to 20% drops in the original. We then tag the last period with a drawdown value of zero as a peak. There was broad consistency in the results using a variety of trigger percentages and drawdown periods. This chart shows our calculated drawdown for NYC.

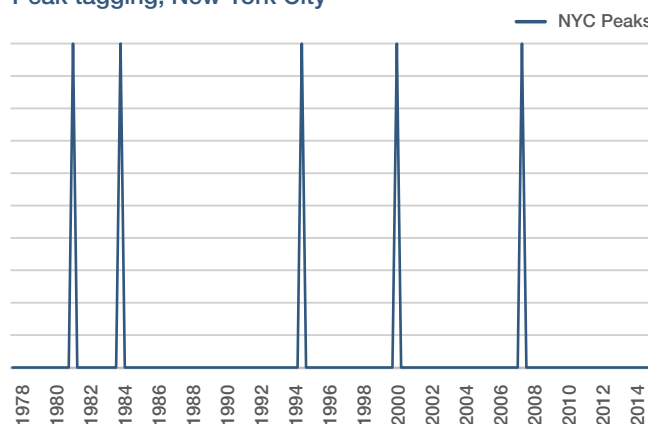
Example 24-month rolling drawdown calculation, NYC



Results:

Below are the results of the peak tagging process for NYC, with a spike representing a peak. This shows that the results are largely unaffected by the choice of lag period. This method was applied to all ten markets, with similar results. This also agrees with common definitions of downturns, capturing the financial crisis, the tech crash, the 1994 commercial real estate bubble, and the downturns of the early 80's.

Peak tagging, New York City



This methodology may be further refined. For example, inflation and trends within the commercial cap rate spreads can be dealt with by replacing spreads with calculated risk premia from a Campbell Shiller decomposition. For the model, the current tagging process accomplishes most of the goals.

Appendix 3: The Model ^{▲▲}

Predicting peaks in commercial real estate is the prediction of an event. More specifically, the time until the occurrence of an event. Before jumping into the mathematics, it may be helpful to examine some edge cases that will help form intuitions around the methodology.

What is the probability of a downturn in the commercial real estate market in the next 20 years? Even knowing very little about the current economic environment, most individuals could venture a guess that in the next 20 years, it is almost certain that we will have a downturn. How about in the next 10 minutes? Downturns do not happen very often, we estimate only 5 have occurred in the last 37 years. Thus the probability of a downturn in the next 10 minutes is unlikely. These examples are not useful predictions, but they are presented to make a point. Even if the cause of downturns, and the overvaluations that precede them, are not well understood, - they can still be forecast in terms of probability.

Mathematical Preliminaries: What are we solving for?

We are looking for a probability distribution for the time of a future event.

$$P(t)$$

Where t is the first occurrence of the event.

That permits us to accurately answer questions of the type: "What is the chance of the event in the next T periods?" This is equivalent to:

$$P(t \leq T)$$

To solve for this function, several models were considered, including a probit model and proportional hazards model but each model had limitations. Ultimately, we developed a new hybrid model /platform that is based, in part, on the probit and hazards models that is an effective prototype for predicting peaks in at least the commercial real estate market.

Probit Model

Probit models have been used in economic modelling to find the likelihood of recessions occurring in the near future. (See: <https://www.kansascityfed.org/publicat/econrev/pdf/2q99fila.pdf>) The basic probit model is:

$$P(\text{peak}|X_{t-k}) = F(\beta X_{t-k})$$

Where β is a vector of covariates, k is a number of periods ahead in the future, and X is a vector of data. F is the cumulative distribution function of the normal distribution. This model answers the question: "What is the chance that a peak will occur exactly k quarters from now?" This matches the model we were attempting to find. Another desirable quality of this model is that answers are often dependent on lagged values of the data. This means that the model only modifies the peak probability by the additional data received in each period. This model has two unfortunate issues:

1. To find our distribution, we need to create a separate version of the model for each lag period.
2. There is no guarantee that the sum of the future probabilities of each of the models will obey the constraints of a probability. (It is often much higher than 100%)

Upon fitting this model, we found the results to be extremely binary. The probability often came to either 1 or 0. This model also failed to capture the long run predictors of downturns, effects that don't cause an immediate downturn, but lead to an overvalued market.

Proportional Hazards Model

To correct for the limitations in the probit regression we decided to investigate a proportional hazards model. The proportional hazards model is often used in healthcare, to assess the effect of different treatments on the risk of certain events. It requires cross sectional data, for example patient sample of events and times, or many events per patient. The hazards model can then be used to estimate a single probability distribution of event times, for each period at risk. (If 5 patients each had two events, the total number of periods at risk is 10.)

The basic hazards model is

$$\lambda_t = \lambda_0(t)e^{\beta X}$$

Where λ_t is the rate of event occurrence at time t , λ_0 is the baseline hazard function, β is a vector of covariates, and X is a vector of data. This model can be fit without specifying the baseline hazards function through the use of an innovative partial likelihood function, as described in Cox 1972 (Regression Models and Life-Tables).

This model has some limitations when it comes to recession prediction, but the most important is the assumption that each period is only part of one distribution for the entire period at risk. At each point in time, the hazard rate only applies to that same period. This can be illustrated through an example.

Say we would like to know the probability of a peak over the next two years, and it is 2004 Q3. Using the proportional hazards model with time varying covariates, we found that the hazard rate is .0034. This means that the probability of a recession this quarter is .34%. This does not answer our question, because this hazard rate says nothing about the future rate of hazard. Even if we (incorrectly) assume that this rate is a constant over the future, we get a 2.7% chance of a peak over the next two years, which is not an accurate assessment of downturn risk.

Hybrid Model – Bayesian Walk

In order to overcome the drawbacks of the probit model and the proportional hazards model, we developed a new hybrid model/platform that is based, in part, on a combination of both models that keeps desirable features of each while overcoming their respective limitations. In accordance with our new model, at each period we produce a distribution of the probability of events at future periods. This distribution is the distribution of future event times, conditional on the data and the event not having happened yet.

One example form for this distribution is the exponential distribution,

$$P(k) = \lambda_t e^{-\lambda_t(k)}$$

Where lambda is the rate of the event. This model makes the assumption that the rate of the event is constant in all future periods, which may be incorrect. Under another example form of our model, this assumption may be relaxed by using a Weibull distribution instead.

The question of predicting downturns now becomes, “What is the current rate of the event, given the data that has been observed?” We begin with a form suggested by Cox 1972 to make the current rate of the event dependent on the observed data.

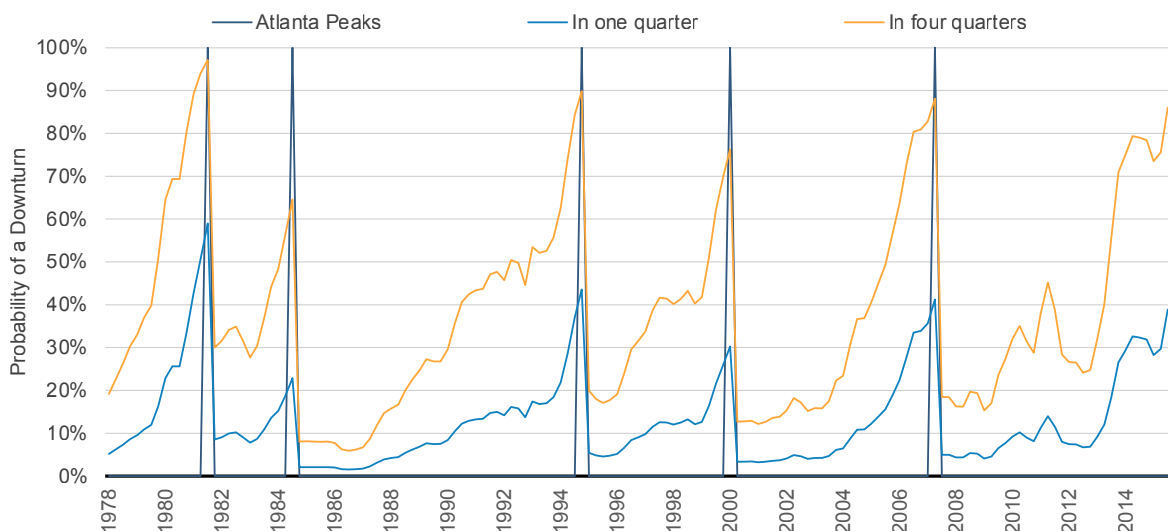
$$\lambda_t = \lambda_0 e^{\beta X_t}$$

Where is a beta vector of covariates and is a vector of data at time t.

We modify this model to account for the specific issues of importance in predicting downturns. It has been noted that the factors that lead to overvaluation are often long term states. It would be inappropriate for the model to change vastly from period to period, as only a small amount of relevant economic information is revealed in each period. Thus we modify the model as follows:

$$\lambda_t = \lambda_0 e^{\sum_{s=0}^t \beta X_s + \alpha}$$

Early Warning Prototype Output, Atlanta



Where alpha is a constant.

Estimation procedure:

The data comes from the peak tagging exercise, with each period having a 1 if it was a peak and a 0 if it was not. We then calculate for each period, the time until the next event. For example if our data were:

0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0, 1

Then we would have:

5, 4, 3, 2, 1, 0, 4, 3, 2, 1, 0, 2, 1, 0

We refer to this time to event data as y_t for each period. For each period the probability of an event occurring in y_t periods is:

$$P(t = y_t) = \lambda_t e^{-\lambda_t(y_t)}$$

The likelihood of the entire dataset is the product of these probabilities:

$$L(Y) = \prod_{t=0}^T P(t = y_t)$$

We then maximize this likelihood with respect to beta and to obtain our data based model of downturn probabilities. This maximization may be done using, for example, non-linear optimization.

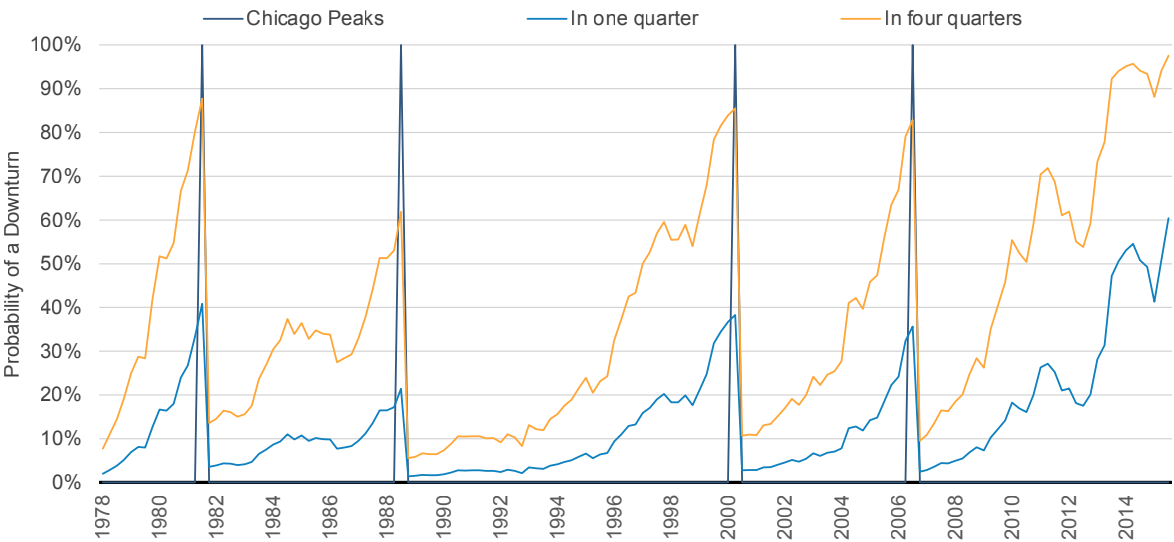
Time Series Estimation Issues:

In order to avoid spurious correlation, all indicator variables were differenced until stationary. Although the probit approach to recession prediction does not often consider autocorrelation of errors, this could become a concern in the new model structure.

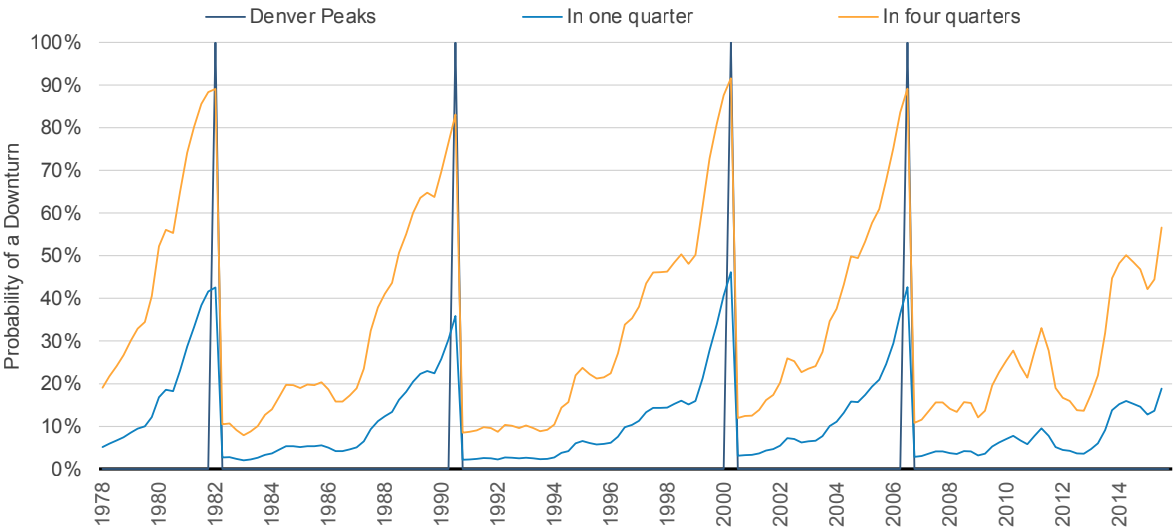
Results:

Below are the results for seven of the markets (the other three are in section 2). Though markets generally have the same peaks, they differ most often in their response to the 1990 savings and loan crisis. The general similarity between markets may indicate that a national model of commercial real estate downturns may be feasible.

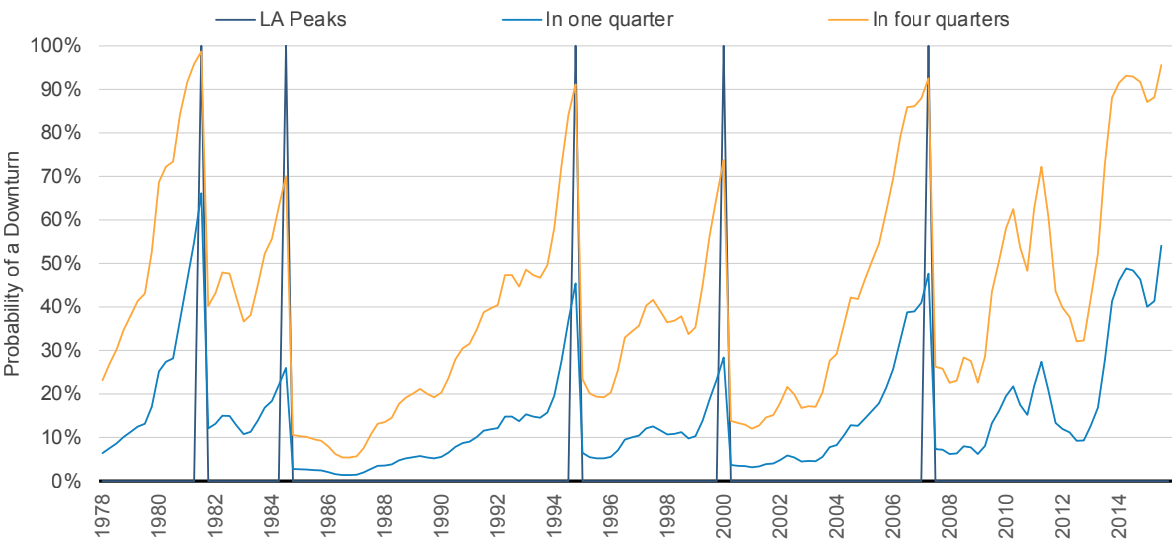
Early Warning Prototype Output, Chicago



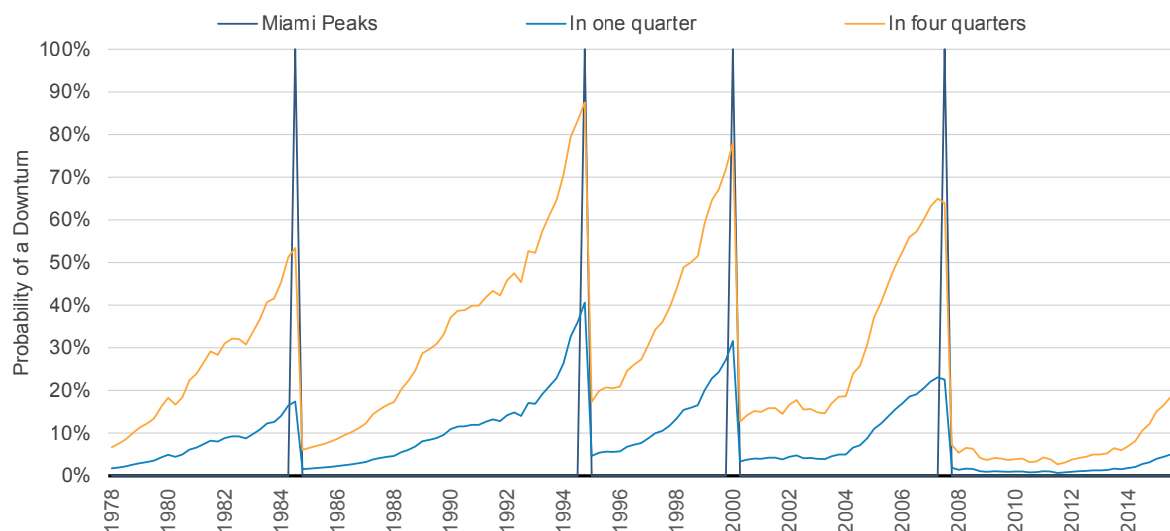
Early Warning Prototype Output, Denver



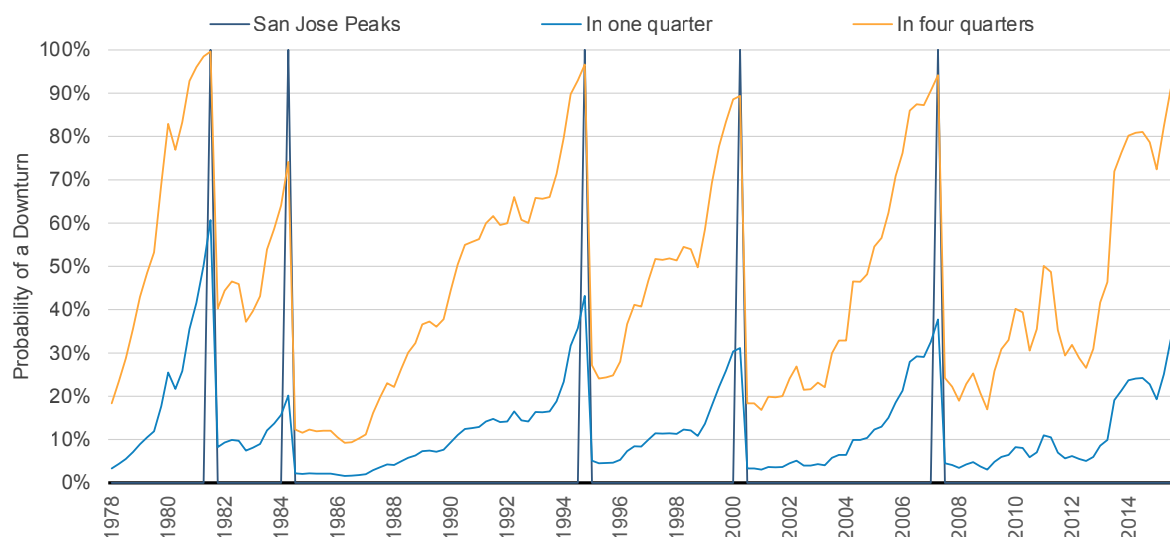
Early Warning Prototype Output, LA



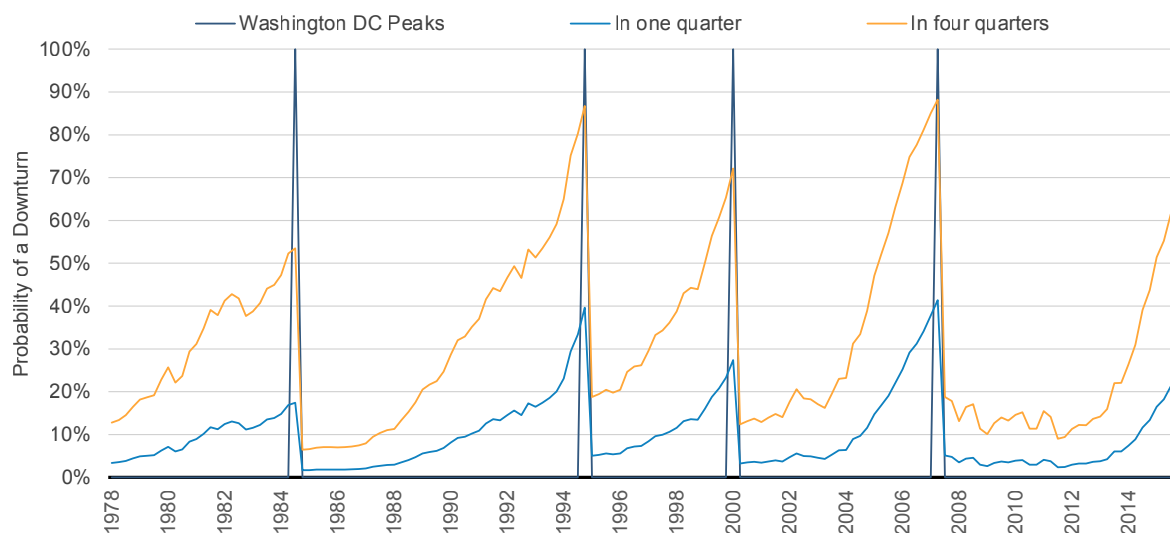
Early Warning Prototype Output, Miami



Early Warning Prototype Output, San Jose



Early Warning Prototype Output, Washington D.C.



Contact Information

The World Economic Forum Infrastructure & Urban Development Industries community aims to serve as a forward-thinking, valuable and internationally recognized partner for all stakeholders involved in infrastructure and urban development. In addition, it seeks to shape the sector's agenda, creating unparalleled opportunities to convene leaders, raise global awareness, conceive frameworks and prepare workable recommendations in the context of improving the state of the world.

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