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The Other (Commercial) Real Estate Boom and Bust: The Effects of Risk Premia and Regulatory Capital Arbitrage

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Abstract

The last decade's boom and bust in U.S. commercial real estate (CRE) prices was at least as large as that in the housing market and also had a large effect on bank failures. Nevertheless, the role of CRE in the Great Recession has received little attention. This study estimates cohesive models of short-run and long-run movements in capitalization rates (rent-to-price-ratio) and risk premiums across the four major types of commercial properties. Results indicate that CRE price movements were mainly driven by sharp declines in required risk premia during the boom years, followed by sharp increases during the bust phase. Using decompositions of estimated long-run equilibrium factors, our results imply that much of the decline in CRE risk premiums during the boom was associated with weaker regulatory capital requirements. The return to normal risk premia levels in 2009 and 2010 was first driven by a steep rise in general risk premia that occurred after the onset of the Great Recession and later by a tightening of effective capital requirements on commercial mortgage-backed securities (CMBS) resulting from the Dodd-Frank Act. In contrast to the mid-2000s boom, the recovery in CRE prices since 2010 has been mainly driven by declines in real Treasury yields to unusually low levels. Our findings have important implications for the channels through which macro-prudential regulation may or may not be effective in limiting unsustainable increases in asset prices.

Keywords: Asset Pricing, Equity Premiums, Bank Deregulation, Institutional Investors, Alternative Asset Classes, Commercial Real Estate.

JEL Codes: G12, G18, G21, G23, R33

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I. Introduction

This study analyzes what drives commercial real estate valuation and finds that shifts in risk premia and regulatory capital requirements were important factors behind the "other" recent boom and bust in real estate—namely that in commercial real estate. The role of the U.S. housing and mortgage bust in the Great Recession has been the focus of much study and regulatory reform, the latter of which has partly sought to limit the damage of asset price declines on the financial system and U.S. economy. However, the boom, bust, and recovery in commercial real estate (CRE) prices (*Figure 1*) were at least as dramatic. According to CoreLogic, nominal house prices in the U.S. increased 75 percent from 2000q1 to their peak in 2006q2.[1] In contrast, CRE prices increased 103 percent from 2000q1 to a peak in 2007q2, according to CoStar.[2] Constant quality house prices decreased 31 percent from peak to trough (2011q4); CRE prices declined 35 percent peak to trough (2011q2).

The lack of research on the CRE boom and bust is noteworthy given the large role it plays in the U.S. According to the Federal Reserve's Financial Accounts of the U.S. (2014q1), the gross real estate holdings of nonfinancial corporations were $10.2 Trillion and the nonresidential real estate assets of nonfinancial, noncorporate businesses totaled $4.3 Trillion, which are sizable compared to the gross real estate assets of households ($20.1 Trillion). Across all sectors, the 2014q1 aggregate holdings of corporate equities, corporate and foreign bonds, Treasury securities, and municipal bonds were $27.9, $12.6, $12.6, and $3.5 trillion, respectively.[3] Although much of the CRE stock is owned by private or government entities for their own use, the stock of investible (traded) CRE assets is sizable, according to other sources (e.g, Geltner, 2014). Clearly, CRE is a major asset class by market value of the stock of assets. CRE also played a large role in recent bank failures (larger than residential real estate according to Antoniades, 2014) as delinquency rates on CRE loans increased more during the crisis than delinquency rates on home mortgages. Declines in CRE prices have also significantly affected business investment (Chaney, Sraer, and Thesmar, 2012).

Both the residential and CRE booms were accompanied by low real interest rates and an increased role of mortgage securitization in funding property acquisitions. In the case of residential housing, the dramatic rise in the issuance of private-label (especially subprime) residential mortgage-backed securities (see Duca, Muellbauer, and Murphy, 2010) helped fuel the boom; in CRE, there was a significant increase in the issuance of commercial mortgage-backed securities (CMBS) (see *Figure 2*; also Levitin and Wachter, 2013, and Stanton and Wallace,

[1] For CoreLogic data see: http://www.corelogic.com/research/hpi/november-2014-corelogic-hpi-national-historic-data.pdf.
[2] More information about the CoStar Indices, is available at: http://costargroup.com/costar-news/ccrsi.
[3] See http://www.federalreserve.gov/releases/Z1/Current/.

2012). Much of the rise in CMBS as a share of commercial mortgages outstanding that began in the early 1990s reflected substitution away from financial intermediaries holding whole mortgages. However, periods when the CMBS share of the outstanding stock rose quickly were usually accompanied by faster growth in the overall stock of commercial mortgages. The substitution and overall growth patterns can be partially attributable to the view that the rise of CMBS increased the liquidity of CRE (see Board of Governors of the Federal Reserve System and SEC, 1998), thereby bolstering both the CMBS share of commercial mortgages and the overall growth rate of CRE loans. Aside from the bank credit crunch of the early 1990s when CRE credit shifted from banks and savings associations to securities markets, there is a notable positive correlation between year-over-year changes in the CMBS share of commercial mortgages and the year-over-year growth rate of the latter (see *Figure 2*).

The timing of post-1995 surges in CMBS share coincides with either regulatory capital avoidance or the effective loosening of capital requirements on CMBS. In the late 1990s, financial innovations gave rise to conduits, which helped partially avoid capital requirements on CRE by enabling nonbank investors to buy debt issued by conduits which in turn purchased CMBS. In the mid-2000s there was another surge in CMBS share around the time when interim and final Basel II regulations reduced capital requirements for banks holding CMBS (Levitin and Wachter, 2013, and Stanton and Wallace, 2012) and when the SEC effectively eased leverage requirements on investment banks, which took positions in ABS. These growth rate patterns are consistent with the evolution of the shares of different forms of holding commercial mortgages (*Figure 3*).

As demonstrated in this study, the roughly parallel surge in the issuance of private-label RMBS and CMBS stimulated by the easing of leverage limits at many institutions investing in these securities. Moreover, our primary data source allows us to identify the key role played by a sharp decline in risk premia on CRE investments. The sharp fall in risk premia and capitalization rates in the early-to-mid 2000s coincided with the rise in CMBS issuance. Stanton and Wallace (2012) find that the spread between Aaa- and Aa- rated CMBS and corporate bond yields fell significantly after a loosening of capital requirements for these highly-rated CMBS in 2002-2004. This evidence is consistent with the argument that regulatory-capital arbitrage contributed to boom and bust in CMBS issuance and CRE prices (e.g., Hendershott and Villani, 2012).[4] Acharya and Richardson (2010, p. 197) state: "But especially from 2003 to 2007, the main purpose of securitization was not to share risks with investors, but to make an end run around capital-adequacy regulations. The net result was to keep the risk concentrated in the financial

[4] Regulatory-capital arbitrage is defined by the Basel Committee on Banking Supervision (1999) as "the ability of banks to arbitrage their regulatory capital requirement and exploit divergences between true economic risk and risk measured under the [Basel Capital] Accord."

institutions—and indeed, to keep the risk at a greatly magnified level, because of the overleveraging that it allowed."[5]

Both the residential and CRE booms were followed by the sudden cessations of private-label RMBS and CMBS issuance—reflective of how vulnerable shadow bank financing is to risk premia and event risks [see Duca (2015), Gennaioli, et. al (2013) and Gorton and Metrick (2012)]–that was followed by a collapse of residential and CRE prices.[6] Our data indicate these steep declines in CRE prices were associated with large increases in risk premia that reversed the sharp declines of the early-to-mid-2000s. The timing of this adjustment of risk premia strongly suggests that it largely was triggered by both increases in general risk premia during the crisis and the Dodd-Frank Act's reversal of the regulatory liberalization of the early 2000s that contributed to the earlier ill-fated twin real estate booms. By estimating the long-run and short-run drivers of both cap rates and CRE risk premia, we quantify the roles played by swings in risk premia, real Treasury rates, and capital availability in driving CRE prices. In addition, our approach allows us to examine whether large and sudden shifts in the ability of financial institutions to arbitrage their regulatory capital requirements helps to explain the dramatic movements in CRE risk premia and prices observed over our sample period.

Using decompositions of estimated long-run equilibrium factors, our results imply that a significant portion of the decline in CRE premia during the boom was associated with weak regulatory capital requirements that enabled banks and other regulated financial firms to take on more risk. These exogenous regulatory changes also may have signaled to other market participants, both foreign and domestic, that CRE's risk, relative to stocks, bonds, and other assets, had declined. The subsequent return to normal risk premia levels was first driven by a steep rise in general risk premia, as tracked by the Baa-10-year Treasury yield spread. However, later in the downturn, the rise in CRE premia is associated with a significant tightening of effective capital requirements on CMBS attributable to Dodd-Frank. Our results also imply that the recovery in CRE prices and declines in required rates of return since 2010 have been driven largely by declining real Treasury yields and, to a lesser extent, a recovery in the availability of financing. The empirical results also indicate that most movements in CRE cap rates reflect changes in the discount factor (required rate of return) rather than in rents, paralleling the core

[5] In contrast, Levitin and Wachter (2013) point out that these changes in regulatory capital also increased the risk-based capital requirements for BB-rated CMBS from 100% to 200%, thereby making lower-rated CMBS much less attractive to banks. The authors argue that making it easier to sell the senior tranches at the expense of restricting the market for the junior tranches "hardly facilitates securitization" and conclude that "it is hard to attribute the CMBS bubble to changes in regulatory capital risk-based weighting requirements." [Levitin and Wachter (2013, p. 31]. However, since our study models cap rates on investments that are primarily in high-end class A properties that would be securitized in top-grade CMBS, the 2004 regulatory capital changes likely apply to the variables used in our sample,

[6] Our depiction and interpretation of the role of CMBS is consistent with that of Geltner, et al. (2014, 383-4, 498-506).

finding of Campbell and Shiller (1988) that stock price movements are larg1ely driven by changes in the discount factor rather than in cash flow (dividends).

From a broader perspective, our study finds that CRE risk premia and prices are associated with movements in general risk premiums, the price and non-price terms of financing, and by financial innovation and regulation. For this reason, our study has policy and behavioral finance implications for CRE markets and the broader banking and financial system.

To establish these findings, our study is organized as follows. Section II discusses how our empirical model specifications are based on the theoretical drivers of CRE pricing and partial adjustment to changes in equilibrium asset prices. Section III presents the data and variables used. Section IV reviews the empirical results and discusses the relative roles played by different factors in driving the boom, bust, and recovery in CRE prices and risk premia. The conclusion reviews the broader implications for asset pricing and regulatory policy.

II. Empirical Specification

The discussion starts with the drivers of equilibrium CRE cap rates and risk premia and is followed by error-correction models that account for the partial adjustment of observed cap rates to equilibrium levels.

II.A Equilibrium Cap Rates and Risk Premia

CRE prices are determined by the interaction of space, capital, and property markets. Local market rents are determined in the space market (i.e., the market for leasable space). Required risk premia for assets with varying degrees of cash flow and price risk are determined in the broader capital market. Finally, asset-specific discount rates, property values, and cap rates are determined in local property markets.

Time-varying property-specific discount rates are a function of the prevailing risk-free rate, investor risk premia, and the risk profile of the specific property, including its relative illiquidity. In the absence of credit frictions, for a given stream of expected annual net operating income (*NOI*) and future sales price, the equilibrium property price at time *t*, P_t^e, equals the present value of the projected *NOI*s discounted at the appropriate risk-adjusted rate, r_t:

$$P_t^e = \frac{NOI_1}{(1+r_t)} + \frac{NOI_1(1+g_{t=2})}{(1+r_t)^2} + \frac{NOI_3(1+g_{t=3})}{(1+r_t)^3} + ... + \frac{NOI_{H-1}(1+g_{t=H})+NSP_H}{(1+r_t)^H}, \quad (1)$$

where H is the marginal investor's expected investment holding period in years and NSP_H is the expected net sale proceeds in year *H*.[7]

[7] *NOI* is assumed to include a reserve for expected capital expenditures and other nonrecurring expenses, such as leasing commissions.

Plazzi, Torous and Valkanov (2010) modify Campbell and Shiller's (1988) log-linearized present value model with time-varying discount and NOI growth rates to study time-variation in expected future returns versus property income in property valuation. Despite being less elegant than the model used by Plazzi, Torous and Valkanov (2010), little is lost in motivating our empirical work with a CRE version of the Gordon Growth model (see, for example, Geltner, Miller, Clayton & Eicholtz, 2007, pp. 209-210). If, *NOI* is expected to grow at a constant rate g_t, and *NSP* is expected to remain a constant multiple of *NOI*, P_t^e is solely a function of the expected constant rate of growth in *NOI* and the property specific risk-adjusted discount rate:

$$P_t^e = \frac{NOI_1}{r_t - g_t} \; or \; \frac{P_t^e}{NOI_1} = \frac{1}{r_t - g_t}. \tag{2}$$

Property value can be expressed as a multiple of first year *NOI*.[8] The equilibrium cap rate, $CapRate_t^e$, is the reciprocal of the price-NOI_1 multiple. From equation (2), it follows that:

$$CapRate_t^e = r_t - g_t. \tag{3}$$

Note that the expected change in *NOI* affects what investors are willing to pay for each dollar of current *NOI*. While investors are unlikely to expect NOI growth rates and discount rates to remain constant in perpetuity, the approximation in equation (3) is consistent with a more general present value model that allows for time-variation in NOI growth and the discount rate to affect CRE valuation and thus the cap rate.

Thus far, equations (1)-(3) were derived in the absence of finance constraints. As motivated in Meen (2001) and empirically verified with U.S. house prices by Duca, et. al (2011), omitting time variation in credit constraints can invalidate the specifications in equations (2) and (3). Time variation in credit constraints complicates the arbitrage between the rent-to-price ratio (observed cap rates) and the user cost of capital (required rates of return) by introducing time-varying wedges between the notional and effective demands for property. In principle and in practice, augmenting eq. (3) with a time series measure of financing available for funding long-run (capital) CRE investments can largely address the effect of finance constraints:

$$CapRate_t^e = r_t - g_t - \mu CapAvail_t \tag{4}$$

where μ is a coefficient >0 and *CapAvail* is a variable tracking capital availability. Essentially, the required rate of return (r_t) controls for the price terms of credit or hurdle risk-adjusted rates of return set in general capital markets, whereas *CapAvail* tracks the impact of non-price terms of finance available for CRE investments. The negative effect of capital availability reflects that

[8] State and federal income tax effects also affect property values and, therefore, price/NOI multiples, as does the cost and availability of mortgage financing.

easier financial constraints make CRE more liquid by raising its effective demand increasing its price and pushing down the cap rate. As a robustness check and to ensure that *CapAvail* is not simply picking up the influence of the price terms of credit, we rerun our models and obtain similar results using a version of *CapAvail* that nets out any contemporaneous or lagged correlation with real Treasury interest rates, corporate-Treasury bond yield spreads, and a proxy for the business cycle (changes in the output-gap).

Turning to other determinants of the cap rate, the risk-adjusted required rate of return has two components: RF_t, the risk-free rate on a Treasury bond with a maturity equal to the property's expected holding period; and $RiskPrem_t$, the required risk premium, which is property, market, and time dependent:

$$r_t = RF_t + RiskPrem_t . \quad (5)$$

RF_t, is largely determined outside of CRE markets as yields on Treasury securities are determined by the bid and ask prices of Treasury market investors from around the world.

What about the determinants of $RiskPrem_t$? CRE competes with other assets in investor portfolios. According to classical portfolio theory, investors select a mix of investments based on the expected returns, variances, and covariance of the returns among potential assets. Bidding among investors simultaneously determines required risk premia for different investments according to their risk profiles. Thus, the pricing of risk depends on risk preferences articulated in the broader capital markets as well as the specific risk profile of the investment, which is determined by current and expected future conditions in the market where the property is located. Owing to transaction cost frictions, the risk premium also includes compensation for the illiquidity of the investment relative to highly liquid Treasury securities.

Specifically, CRE risk premia can be parsimoniously modeled as a function of general asset risk premia—which we proxy with the spread between Baa corporate and 10–year Treasury yields—and factors affecting the relative liquidity of CRE. The latter could include short-run cyclical factors because CRE is a long-duration asset whose large fixed costs and transaction costs along with illiquidity make its returns more cyclical than many other assets.

Regulatory restrictions on the holding or issuance of CRE debt by financial firms also affect the relative liquidity of CRE assets given the large role banks played in originating and securitizing CRE mortgages.[9] For example, at the margin less liquid CRE mortgage assets tend to either be held by banks, which have liquidity backing from the Federal Reserve but face

[9] According to the *Financial Accounts of the United States*, commercial banks hold approximately 40 percent of the outstanding stock of commercial mortgages. (Federal Reserve, December 11, 2014, various tables, http://www.federalreserve.gov/releases/z1). Their share of CRE mortgage originations is even larger.

minimum regulatory capital requirements, or be securitized by entities subject to regulatory stress tests that require them, under Dodd-Frank, to retain a five percent first loss position on CRE mortgages they securitize. Lower effective capital requirements reduce illiquidity and risk premia on CRE assets. As discussed later, this view is consistent with the compression of CRE risk premia that occurred in the mid-2000s following the 2004 reduction in capital requirements on holding CMBS.

These considerations imply that $RiskPrem_t$ can be empirically modeled as a function of long-term factors (Baa – Treasury bond yield spread and CRE capital requirements) toward which risk premia only partially adjust owing to sizable transaction costs. CRE risk premia are also driven by some short-run and primarily cyclical factors.

Thus far, the discussion of risk premia has omitted mention of the role of capital availability in funding purchases of CRE assets. In principle, capital availability may arguably affect the liquidity of CRE assets and thereby their liquidity and thus their risk premiums. However, the survey from which average answers are used to measure required rates of return and expected rent growth on CRE assets also provides respondent's assessments of the availability of investment capital to purchase CRE assets. It is very plausible that respondents may have attributed to capital availability both its direct effect on cap rates and its indirect effects on the risk premia demanded by investors on CRE properties. As a result, the capital availability index from the RERC survey may not add much information to empirical models of the risk premium, especially if they include a general risk premium such as the Baa-Treasury bond yield spread. Indeed, in runs that include this spread but are not shown below, we find that the capital availability index is statistically insignificant in empirical models of the risk premia.

II.B. Error Correction Models of Cap Rates and Risk Premia

In highly liquid public markets, asset prices adjust quickly to changes in economic fundamentals, such as interest rates, inflation expectations, and national and local market conditions. However, in private CRE markets, cap rates may adjust slowly to new information. This slower adjustment speed reflects inefficiencies in CRE markets, such as high transaction costs, lengthy decision making and due-diligence periods, informational inefficiencies, and significant limits to arbitrage (short-selling). A number of authors have estimated structural models derived from theoretical cap rate models to analyze property price dynamics [Chervachidze and Wheaton, 2013, Sivitanides, Torto and Wheaton (2001), Hendershott and MacGregor (2005), Plazzi, Torous and Valkanov (2010), and Sivitanidou and Sivitanides (1999)].

To model the long-run and short-run dynamics of cap rates and risk premia, we use error-correction models to estimate changes in cap rates and risk premia as an adjustment process toward estimated equilibrium values. Error-correction models are based on the idea that two or more time series exhibit a long-run time-varying equilibrium to which they tend to converge. The long-run influence in such models occurs via negative feedback and error correction, and this influence reflects the degree to which long-run equilibrium forces drive short-run dynamics (see Engle and Granger, 1987, and Hamilton, 1994).

Our long-run cap rate and risk premium models are specified in levels. The short-run adjustment models are specified in first differences and include an error correction term from the estimation of the long-run (equilibrium) model. In the long-run model, theory and econometric evidence are used to determine whether the various data series contain unit roots and are cointegrated. If the data series are cointegrated, a long-run equilibrium relation (i.e., a cointegrating regression) can be specified in levels as:

$$Y_t = \beta_0 + \sum_{i=1}^{n} \beta_i X_{it} + \upsilon_i \ , \tag{6}$$

where Y_t represents either the cap rate or risk premium, X_{it} are n theoretically-based long-run explanatory variables, and υ_t is a white noise error term. The error-correction term (EC) is defined as the difference between the actual dependent variable (Y_t) and its estimated equilibrium value ($\sum_{i=1}^{n} \beta X_{it}$) of the cap rate or risk premium.[10] If the residuals from equation (6) are stationary, the EC term enters the model of short-run changes in the cap rate and risk premia as follows:

$$\Delta Y_t = \alpha_0 + \gamma EC_{t-1} + \sum_{j=1}^{k} \theta_j \Delta Y_{t-j} + \sum_{j=1}^{k} \sum_{i=1}^{n} \alpha_i \Delta X_{it-j} + \varepsilon_i \ , \tag{7}$$

where $\Delta Y_t = Y_t - Y_{t-1}$ is the first difference of the cap rate or the risk premium and ΔX_{it} are first differences of the explanatory variables. The number of lags (k) of the first difference terms is selected to obtain a unique and significant cointegrating vector yielding clean residuals (ε_t). Following Johansen (1995), equations (6) and (7) are estimated simultaneously. Estimation of equation (7) provides evidence on short-run cap rate and risk premium dynamics (the α_i's) and adjustments to the previous disequilibrium in the long-run equilibrium relation, γ (the speed of adjustment parameter). If γ=1, there is full adjustment; γ=0 suggests no adjustment.

Based on our earlier theoretical discussion of equilibrium factors influencing cap rates, we estimate the following long-run empirical model of cap rate levels:

[10] The specification in equation (6) uses the results of equation (3) to specify the equilibrium cap rate as a function of the discount rate, r_t, and expected NOI growth, g_t, but does not impose the exact relationship, $CapRate_t = r_t - g_t$, that holds under the constant income growth assumption.

$$CapRate_t^e = \alpha_0 + \alpha_1 ReqRtn_t - \alpha_2 RentGrowth_t + \alpha_3 CapAvail_t + \upsilon_t, \quad (8)$$

where we expect—based on the earlier discussion—that $\alpha_1>0$, $\alpha_2>0$, and $\alpha_3>0$, and where $ReqRtn_t$ is the required total return on investment, $RentGrowth_t$ is the expected long-run annual percentage change in *NOI*, and $CapAvail_t$ measures capital availability for CRE to track non-price credit terms. $ReqRtn_t$ equals the yield-to-maturity on 10-year Treasury securities plus a risk premium. According to the classical valuation model in equation (3), the cap rate is increasing in *ReqRtn* (*r*) and decreasing in *RentGrowth* (g). Greater capital availability should lower cap rates by increasing the liquidity of and effective demand for CRE as in equation (4).

Our short-run error correction cap rate model is:

$$\Delta CapRate_t = \beta_0 + \beta_1 EC_{t-1} + \sum \beta_{2i} \Delta CapRate_{t-i} + \sum \beta_{3i} \Delta ReqRet_{t-i} + \quad (9)$$
$$+ \sum \beta_{4i} \Delta RentGrowth_{t-i} + \sum \beta_{5i} \Delta CapAvail_{t-i} + \varepsilon_t,$$

where $EC_{t-1} = CapRate_{t-1} - CapRate^*_{t-1}$. According to equation (8), equilibrium cap rate levels are driven by three primary factors: discount rates that reflect the risk-free opportunity cost of equity capital and the unlevered equity risk premium; variables influencing NOI growth expectations; and the availability of capital for CRE investments. Cap rate changes [equation (9)], in turn, are a function of lagged changes in these long-run determinants, as well as the extent to which cap rates differ from their equilibrium level in the previous period.

We also estimate the following long-run model of the risk premium:

$$RiskPrem_t^e = \alpha_0 + \alpha_1 BaaTR_{t-3} + \alpha_2 RegCap_t + \upsilon_t, \quad (10)$$

where $BaaTR_{t-3}$ is the spread between the yield on Baa corporate and 10-year Treasury bonds and $RegCap_t$ measures the stringency of the effective capital requirement for banks to hold or securitize CRE mortgages. Following Chervachidze, Costello, and Wheaton (2010) and Chervachidze and Wheaton (2013), we include *BaaTR* to track the influence of general risk premia in capital markets that affect a broad spectrum of asset prices. *RegCap* tracks how regulations affect the liquidity and perceived risk of CRE relative to other major assets for institutional investors, as discussed in more detail in the data section.

Our empirical short-run error correction risk premium model takes the form:

$$\Delta RiskPrem_t = \beta_0 + \beta_1 EC_{t-1} + \sum \beta_{2i} \Delta RiskPrem_{t-i} + \sum \beta_{3i} BaaTR_{t-i} + \beta_{4i} \Delta RegCap_{t-i} + \beta_5 X + \varepsilon_1, \quad (11)$$

where X is a vector of stationary cyclical and risk terms and $EC_{t-1} = RiskPrem_{t-1} - RiskPrem^*_{t-1}$.

III. Data

Data limitations may explain why the study of private CRE markets has not been embraced by the mainstream financial economics literature. The nature and functioning of CRE markets differ significantly from frequently studied public securities markets. In CRE markets, it is difficult to observe and obtain large quantities of income, pricing, and trading data. This is because CRE assets are generally exchanged in private deals between one buyer and one seller (Geltner, 2014). Although the public recording of CRE transactions is common, it is not ubiquitous and it has not resulted in centralized databases.

Although progress is being made on compiling CRE transaction data, such efforts cannot overcome a larger issue: CRE assets, and the leases that drive rental income, are heterogeneous and properties trade only infrequently. Thus, it is not possible to create constant quality price indices by tracking mean selling prices or even mean per square foot sale prices over time. The small transaction samples also limit the frequency with which even constant quality indices, such as those produced by CoStar and Moody's/RCA (www.rcanalytics.com/Public/rca_cppi.aspx), can be constructed. These state-of-the-art CRE indices, which do not include the income component of the total return, are calculated on a quarterly basis and only at the national or regional levels.

Owing to the limitations and lack of availability of transaction-based CRE returns, we use survey data to track the non-regulatory, long-run determinants of cap rates and risk premia. Two measures are defined to track the long-run effect of financial regulations. Additional variables are used to control for special short-run factors influencing cap rates and risk premiums.

IIIA. Non-Regulatory Long-Run Variables

Our primary data source is the Real Estate Investment Survey, the results of which are published quarterly in the *Real Estate Report* by the Real Estate Research Corporation (RERC). The survey results summarize information on current investment criteria, such as acquisition cap rates, required rates of return on equity, and expected rental growth rates, from a sample of CRE investors, lenders, fee appraisers, and managers in the U.S. The survey focuses on "institutional grade" assets that are owned and financed by pension and endowment funds, life insurance companies, private equity funds, investment banks, and real estate investment trusts. A distinct advantage of the RERC data is the ability to abstract required risk premia, which are critical to our analysis.[11]

Two potential concerns are that surveyed cap rates and discount rates might reflect forecasted or aspirational rates rather than required rates and that both might lag actual changes in required cap rates and discount rates. However, the RERC survey is careful to specify

[11] For more details, see http://store.rerc.com/collections/real-estate-repor.

that it is asking for current required cap rates and discount rates. Nevertheless, to further address these potential concerns and for robustness, we also employ similar survey data on cap rates from PriceWaterhouseCoopers (PWC). We obtain the same qualitative analytic results, likely reflecting how the RERC cap rate movements generally coincide with those in PWC and NCREIF cap rates.

Ideally, cap rate data would be based on a large number of sale transactions for properties of constant-quality and identical lease terms. As discussed above, such data do not exist. RERC data, however, track the cap rates and risk premia survey respondents require in the market for notional institutional grade properties of constant quality. Thus, because these data are not based on actual heterogeneous properties and transactions, they are well-suited to this study.

As specified in equation (8), equilibrium cap rates ($CapRate_t^e$) are a function of required rates of return on equity ($ReqRtn_t$), expected growth rates in *NOI* ($RentGrowth_t$), and the availability of capital. However, $ReqRtn_t$ and $RentGrowth_t$ cannot be directly observed in transaction data. Therefore, in prior cap rate studies, proxies for these critically important variables have been estimated. An additional attraction of the RERC data is that expected rental growth rates and required equity returns are two of the survey questions. However, information on discount rates and risk premia are not available from the RERC survey until the 1996q1, which dictates the beginning of our sample period.

Due to a notable downshift (about one percentage point) in long-term inflation expectations during the early part of our sample from roughly 3 to 2 percent (*Figure 4*), real measures of the *CapRate*, *ReqRtn*, and *RentGrowth* are derived by adjusting nominal values from the RERC and PWC surveys with the 10 year-ahead expectation of inflation from the Federal Reserve Board model. Doing so eliminates spurious correlations arising from a fall in long-run inflation expectations from the mid-1990s to 2000s and makes these variables consistent with other real variables, such as the effective capital requirement on CRE assets, risk premia on the four CRE categories,[12] and the capital availability index, whose ordinal nature (respondents rank capital availability on a scale of 1 to 10) and time series behavior imply that it is a real rather than a nominal measure of capital availability. For ease of exposition, henceforth references to capitalization, expected rent growth, and required rates of return refer to real magnitudes adjusted for long-run inflation expectations. Nevertheless, we obtained the same qualitative results and similar estimated coefficients using nominal versions of these variables,[13]

[12] Our risk premium measures are real insofar as they equal the nominal required rate of return minus the nominal 10-year Treasury yield, the latter of which already incorporates compensation for long-run expectations of inflation.
[13] One difference is that the coefficient on nominal required returns is closer to—and not statistically different from –unity.

We focus first on mean capitalization rates reported by RERC for four property types: apartments, industrial warehouse, central business district (CBD) office properties, and regional (retail) malls. Cap rates for these property types, adjusted for expected inflation, were relatively stable from 1996 to 2002 (*Figure 5*). However, in 2002, cap rates on all four property types began to decline. For example, real apartment cap rates fell from 6.4 percent in 2002q1 to 3.5 percent by 2007q2. Holding *NOI* constant, this implies an 83 percent increase in property values.[14] Cap rates on warehouse, office, and retail properties also plunged during the 2002-2007 CRE boom. However, beginning in late 2007 and early 2008, cap rates soared. For example, apartment cap rates rose 240 basis points to 5.9 percent from 2007q2 to 2009q4. This steep rise, coupled with generally declining rental income, produced large declines in typical CRE prices.

To address potential concerns about the survey-based nature of our cap rate data, we compare cap rates by property type from RERC with those from three other sources: PWC; the National Council of Real Estate Investment Fiduciaries (NCREIF), and Real Capital Analytics (RCA). Similar to RERC, PWC gathers quarterly responses from prominent pension plans, foundations, endowments, life insurance companies, investment banks, and REITs that invest in or finance U.S. CRE. Respondents report the cap rates they observe on CBD office, major retail, apartment, and industrial warehouse properties. Similar to the RERC survey, the PWC survey asks respondents for their required (unlevered) rates of return on equity and rental growth forecasts for each property type. Because retail and industrial property types are aggregated together in the PWC survey, the PWC results are not directly comparable to retail and industrial RERC data, which are disaggregated by sub-property type.[15] However, the PWC and RERC data for apartments and CBD office properties are directly comparable.

NCREIF cap rates are averages derived from valuations of institutional grade properties held by firms that are contributing members to the NCREIF Property Index (NPI).[16] RCA cap rates are averages derived from a much larger, more heterogeneous, sample. These cap rates come from the sales of all properties of $5 million or more. NCREIF cap rates are largely appraisal-based, and hence potentially smoothed and backward looking. RCA cap rates are transaction-based but potentially noisy because they are not constant quality and because NOIs must be estimated. NCREIF data start in 1990, while RCA data begin in 2001.

The correlation between quarterly real RERC and PWC cap rates for CBD office and apartments are 0.976 and 0.972, respectively, from 1996q1 to 2014q3. Although retail and industrial properties are not fully comparable, the cap rate correlations for the two property

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[14] $[(1/0.035) \div (1/0.064)] = 1.83$.

[15] See http://www.pwc.com/us/en/asset-management/real-estate/publications/pwc-real-estate-investor-survey.jhtml

[16] For more information, see www.ncreif.org.

types are still 0.923 and 0.929, respectively. The correlation between RERC and NCREIF cap rates for our four property types range from 0.889 for regional malls to 0.962 for CBD offices.[17]

The correlation between RERC and RCA cap rates over the shorter 2001Q1 to 2014Q3 period are as follows: regional malls, 0.876; CBD office, 0.557; warehouses, 0.889; and apartments, 0.909. Except for the low correlation between the office cap rates, the tight connection between RERC cap rates and these alternative series indicates that RERC cap rates are tracking pricing dynamics in CRE markets very well.

Table 1 contains summary statistics, by property type, for our key RERC regression variables over the 1996q1 to 2014q3 sample period. Mean real capitalization rates range from 5.0 percent for apartments to 5.7 percent for industrial warehouses. Cap rates for all property types vary significantly over the sample period and are highly serially correlated. With the exception of regional malls, cap rates changes display moderate serial correlation. The quarterly cap rates for each of the four property types are plotted in *Figure 5*.

Mean expected rent growth ranges from 0.2 percent (annually) for regional malls to 0.6 percent for apartments. The level of expected rent growth also display substantial variation over the sample, as well as positive serial correlation across quarters. However, changes in expected rental growth rates generally display significant negative serial correlation, suggesting some amount of mean reversion in rent growth expectations.

With the slight exception of apartments, average discount rates (required IRRs) vary little across property type. Required risk premia (required unlevered returns minus the 10-year Treasury bond yield) average 5.0 percent for apartments and 5.4 percent for regional malls, CBD offices, and industrial warehouses. Although risk premia are similar across property types, they do vary significantly over the sample. For example risk premia on CBD office properties ranges from 2.8 percent (2007q2) to 7.2 percent (2002q4). Required risk premia also display substantial serial correlation in levels, although no statistically significant serial correlation in changes.

The inability of survey respondents to detect cross-property differences in ex ante risk premia seems inconsistent with the significant variation in ex post returns earned over different time horizons. However, similarity in risk premia across property types and their persistence over time suggests investors are unable to detect differences in systematic risk across property types and over time. Shilling (2003) and Geltner et al. (2007) report a similar finding in ex ante required returns from real estate investor surveys.

[17] These correlations are based on equally-weighting all of the properties in the NCREIF database. NCREIF also publishes value-weighted cap rates. The correlation among the two for the four property types range from 96 percent for regional malls to 99 percent for apartment properties.

It is important to note that institutional grade properties are the lowest risk CRE investments available. Properties are below institutional grade owing to their smaller size, advanced age, location in a small or transient market, or lack of tenants, and command higher risk premia. In addition, the pervasive use of leverage in CRE markets further increases risk and required risk premia.

The price indices and cap rates plotted in *Figures 1* and *5* clearly display the CRE boom, bust, and subsequent recovery that occurred from 2003-2014. For example, during the 2003q4-2007q2 price boom, real cap rates on investment grade CBD office buildings decreased 2.1 percentage points. This cap rate decrease occurred despite a 72 basis point increase in real 10-year Treasury yields. However, CBD office risk premia fell 300 basis points over this boom. This risk premium decline can be linked to a boom in the structured finance/CMBS market. *Figure 6* plots the issuance of CMBS and non-prime RMBS, along with the value of outstanding credit default swaps (CDS). Despite being smaller in dollar magnitude than the surge in non-prime RMBS issuance, the 2005-07 growth in CMBS issuance is still unprecedented. This structured finance/CMBS boom resulted in a "wall of debt capital" flooding CRE and housing markets with a concomitant increase in property liquidity and a drop in CRE risk premia among the four property types (see *Figure 7* and *Figure 8*, for a plot of the real required internal rate of return).

There is an additional, and more traditional, explanation for the steep decline in cap rates during the boom. Although not separately tabulated, expected rental growth rates for CBD office properties increased 1.5 percentage points during the boom. The increases for other property types were similar. The increases in real expected rent growth during the boom seem inconsistent with forward looking (fundamentals-based) rent growth expectations. Once CRE market values exceed all-in construction costs, rising prices (lower cap rates) induce more construction by profit-seeking developers, leading to lower real rents, all else equal, in the long-run due to the increase in supply of leasable space relative to demand. In other words, an increase in capital flows and liquidity pushes property values above construction costs, inducing forward-looking market participants to reduce their long-run real rent growth expectations. However, this did not happen until the bust in CRE prices.

During the 2007q2-2009q4 CRE bust, cap rates on office properties rose 250 basis points. This sharp increase in cap rates occurred because the required risk premium rise of 299 basis points exceeded an 9 basis point decline in 10-year Treasury yields (see *Figure 7)*. Compounding the negative effects of rising risk premiums, expected long-term office rent growth plunged by 160 basis points. The increase in risk premia was driven by the global financial crisis, including the collapse of the CMBS market (see *Figure 6*). The decline in expected rent growth reflected the negative impact of the financial crisis on the real economy, including lower tenant demand for office space. The 2007q2-2009q4 bust among the other three property types was also driven by the global financial crisis and reduced demand for leasable space.

Following the Great Recession, real office cap rates decreased 297 basis points during the 2009q4-2014q3 recovery. This plunge offsets the increase in real cap rates that occurred during the bust and was driven by a 152 basis point decline in real 10-year Treasury yields, a 104 basis point decrease in risk premia, and a 164 basis point increase in the mean real expected rental growth rate. The volatility of CRE cap rates and risk premia over the boom, bust, and recovery are striking.

In addition to providing data on cap rates, required rates of return, and expected rent growth, RERC respondents rank the current availability of capital for investment on a scale of 1 to 10, with 1 indicating "poor" and 10 indicating "excellent" access to capital. We define $CapAvail_t$ as the mean response in quarter t. An increase in $CapAvail_t$ therefore indicates respondents believe capital availability has increased over the prior quarter. $CapAvail_t$ averaged 7.3 during the sample period, ranging from 1.8 in 2008q4 to 9.6 in 2005q3. As illustrated in *Figure 4* capital availability sharply declines beginning 2008q3 and begins to recover in 2009q1. This proxy for capital availability is broad enough to encompass changes in the CRE underwriting standards of banks (see Ling, Naranjo, and Scheick, 2014) and security market funding (see Wilcox, 2012), whose relative roles have shifted over our sample period. As a robustness check, we also employ a version of this measure in our regression analysis that is stripped of fundamentals.[18]

IIIB. Regulatory Long-Run Variables

Two variables are used to model the long-run impact of regulations on CRE pricing. *RegCap* equals the minimum effective capital requirement for holding or securitizing CRE mortgages originated by a bank or systemically important financial institution that is subject to stress testing (this includes the major CMBS issuers).[19] Between 1990 and 2004q2, Basel I required banks to have a minimum of 8 percent equity capital holdings to fund CRE loans or CMBS held in portfolio. The final Basel II requirements lowered the risk weight for banks on Aaa- and Aa-rated CMBS to just 20 percent of the eight percent (Blundell-Wignall and Atkinson, 2008). Although this cut was adopted on an interim basis in 2002 (Stanton and Wallace, 2012) and via an expectations effect altered CMBS spreads that year, the 2002 interim rules did not apply to foreign banks and its provisional nature likely deterred much pre-final Basel II issuance

[18] Chervachidze and Wheaton (2013) also argue that macroeconomic capital flows can affect CRE prices and use the growth rate in the ratio of total debt in the economy to GDP.
[19] In May 2006, investment advisors and money managers (including investment banks) held about 32 percent of CMBS, with commercial banks and insurance companies owning about 23 percent each.

by U.S. domiciled banks until late 2004. The final Basel II accord (announced in June 2004) effectively cut the capital requirement from 8 to 1.6 percent, inducing a large rise in bank CMBS holdings (Blundell-Wignall and Atkinson, 2008).[20]

To reflect this change, *RegCap* equals 1.6 percent from 2004q3 to 2010q2, when Dodd-Frank made other changes Moreover, it was not until mid-2004 that the SEC eased the leverage limits on investment banks that effectively lowered the regulatory requirement on CRE from 6.7 percent to 3 percent in June 2004—providing another reason for assuming the change took effect in mid-2004 rather than in 2002. This easing was later reversed by the conversion of the four surviving major U.S. investment banks into commercial banks in 2008 and 2009,[21] along with the tightening imposed by Dodd-Frank, which became law in 2010.

Dodd-Frank restored the risk weight on investment-grade CMBS to 100 percent, raised the minimum capital ratio on CRE assets held to 10.5 percent from 8 percent for most banks, and required higher capital for systemically important banks.[22] Banks could securitize loans to avoid baseline capital requirements on CRE held in portfolio, but Dodd-Frank compels any securitizer to retain a 5 percent first loss position in a securitized CRE mortgage. Dodd-Frank also requires banks to take stress tests and hold enough capital to survive scenarios of deep recessions and lower asset prices. Together, stress tests and skin-in-the-game securitization rules imply that commercial banks and most other CMBS issuers hold 5 percent minimum capital against securitized CRE mortgages. To reflect this, *RegCap* equals 5 percent after 2010q2.[23]

We employ an alternative regulatory capital variable (*BaselSEC*), which is a binary variable. Our sample begins in the Basel I era when, as noted above, banks faced an 8 percent minimum capital requirement on holding CRE loans and CMBS in portfolio, and when investment banks faced an effective minimum capital requirement of 6.7 percent. In the summer of 2004, not only were the Basel requirements on commercial banks eased via lowering the risk weights on CMBS but also the SEC's leverage limit on investment banks was effectively lowered by allowing a broader definition of capital.[24] These lower limits continued until 2010q2 when Dood-Frank essentially undid the easing of regulatory requirements. To reflect these broad

[20] A-rated securities had a 50 percent risk-weight, below the 100 percent weight on whole mortgages. Stanton and Wallace (2012) estimate this change saved U.S. banks $3.5 billion in regulatory capital.
[21] Bear Stearns was acquired by J.P. Morgan Chase, Merrill Lynch was acquired by Bank of America, and Goldman Sachs and Morgan Stanley converted to commercial banks that have access to Federal Reserve liquidity facilities.
[22] This reflects a countercyclical capital buffer and a capital conservation buffer. Systemically important banks are subject to an additional 1-4 percent surcharge.
[23] See Duca (2014) for a similar discussion regarding business loans. Before Basel I, banks faced a minimum capital requirement of 5 percent until 1984 and 5.5 percent between 1985 and 1987. Dodd-Frank returned the effective minimum capital requirement to near the pre-Basel I level (Duca, 2014).
[24] Leverage at four of the five large U.S. investment banks doubled between mid-2004 and late 2005 (*Economist,* 2012). Lo (2012) contends that the leverage limit was doubled, whereas Sirri (2009) argues the definition of capital was eased.

regime changes, *BaselSEC* equals "0" between 1996 and 2004q2, "1" during the 2004q3-2010q2 period of regulatory liberalization, and "0" after 2010q2.[25]

IIIC. Short-Run Variables

Several short-run stationary variables are included in many models to control for cyclical factors or unusual short-run shocks. The t and $t-1$ lags of the percent change in the leading economic indicators (*LEIGR*) are included in the Δ*RiskPrem* equations to control for current and expected near-term cyclical effects. Another short-run variable, *GovtShut*, equals 1 in 2013q3 to control for the imminent early October 2013 shutdown of the federal government. By creating uncertainty about the liquidity of Treasury debt, this event narrowed risk premia by temporarily elevating Treasury yields in 2013q3. Treasury debt is usually viewed as free of default risk and most liquidity risk. Thus, a narrowing of the Baa-Treasury bond yield spread is usually driven by a fall in default and liquidity risk on private debt. Hence, the narrowing of *BaaTr* in 2013q3 reflects an unusual departure from past behavior. This, coupled with the lagging of levels and first differences of variables in the cointegrating vector, implies that the error-correction model would not pick up the anticipatory effect in 2013q3 of the October 2013 government shutdown.

Many models include the $t-1$ first difference of the CBOE volatility index, VIX (ΔVIX). VIX is a key measure of market expectations of near-term volatility conveyed by S&P 500 stock index option prices. Including ΔVIX may capture other aspects of asset price risk not fully reflected in the investment grade corporate and Treasury markets. The first difference of *VIX*, although not its level, is stationary in our sample. In other runs (not tabulated) in which the level of the *VIX* replaces *BaaTR*, model fits and speeds of adjustment were smaller; in other runs, multi-collinearity between these risk premium proxies made it difficult to identify separate, significant long-run effects of either. For this reason, *BaaTR* is used to track long-run general risk premia, and ΔVIX_{t-1} is included in short-run models to track additional shifts in risk premia on less liquid assets (such as CRE) without complicating the identification.

[25] Congress passed the Interstate Banking and Branching Efficiency Act (IBBEA) in 1994, which permitted banks and bank holding companies to expand across state lines. Chu (2014) treats this as an exogenous shock to credit supply, finding it to have a causal and potent effect on CRE prices.

IV. Empirical Estimates

IVa. General Approach to Estimating What Drives Cap Rates and Risk Premia in the Short- and Long-Runs

Cointegration techniques are used because cap rates and risk premia for each property type and their long-run determinants are nonstationary and have unit roots, implying trends that can complicate statistical analysis.

The estimation of long-run and any short-run relationships is joint following Johansen (1995), and depends on the exogenous short-run factors included (the vector *X*). In general, we took the approach of estimating a set of models that include a minimal number of short-run variables. However, we also estimate models with additional highly relevant short-run factors as a robustness check and to address concerns about the choice of short-run variables. The number of lags was chosen as the minimum lags required to obtain a unique significant cointegrating variable and to, if possible, yield clean model residuals using the VECLM statistics on lags $t-1$ through $t-4$. The estimation allowed for possible time trends in long-run variables without an independent time effect in the vector not attributable to measured factors.

In what follows, estimates of long-run determinants of cap rates are presented first, followed by a discussion of short-run results. The long-run estimates are then used to decompose which factors drove the mid-2000s boom in CRE prices, the subsequent bust, and the recent recovery. Against this backdrop, the section then proceeds to examine findings regarding long-run and short-run movements in risk premia before ending by decomposing which factors have driven long-run movements in risk premia.

IVb. What Drives CRE Cap Rates in the Long-Run?

In the long-run, equilibrium cap rates should be increasing in required rate of returns and decreasing in expected rent growth and capital availability. Each of these variables is included in the estimated cointegrating vectors reported in the upper panel of *Table 2*. Two models are presented for each of the four property types: office, apartment, industrial warehouse, and retail shopping malls. In each model, the only additional short-run variable is the $t-1$ lag of the first difference of *VIX*. The odd-numbered models use the actual, raw capital availability index.

One concern about including the capital availability index is that it may reflect cyclical factors, risk premia, and real interest rates, which, in principle, complicates how to interpret coefficient estimates. To address this concern, the even numbered models substitute a cyclically-adjusted capital availability index, which is based on the following full sample regression:

$$CapAvail_t = \underset{(10.95)}{10.55} - \underset{(1.48)}{0.144}\text{x}\Delta GDPGap_{t-1} - \underset{(2.88)}{0.279}\text{x}\Delta GDPGap_{t-2} - \underset{(5.32)}{0.988}\text{x}BaaTR10_t - \underset{(1.22)}{0.182}\text{x}RTR10_t - \underset{(2.42)}{0.084}\text{x}D073 - \underset{(3.16)}{1.133}\text{x}D084$$

$\rho = 0.929$; adj.$R^2 = 0.933$

Absolute t-statistics are in parentheses, $\Delta GDPGapt \equiv$ first difference of the GDP output gap as a percent of potential GDP (CBO estimates), and $RTR10_t \equiv$ real 10-year Treasury bond yield (using the Federal Reserve Board model's expectation of 10-year ahead inflation). The BaaTR spread and the real 10-year Treasury rate are netted out because they are measurable components of the real required rate of return on CRE investments that reflect general market risk conditions and the real riskless interest rate, respectively. *D073* is a dummy variable equal to 1 in 2007q3 when the onset of the financial crisis was triggered by the suspension of withdrawals from private equity funds invested in subprime securities that could not be priced given the lack of market trading. *D084* is a quarterly dummy equal to 1 in 2008q4 to control for an unusual drop in capital availability just after Lehman Brothers failed. The adjusted capital availability index equals the raw index minus the estimated index. The adjusted index therefore reflects capital conditions abstracting from variation in the business cycle, standard default risk, and real riskless interest rate. If the adjusted index is significant we can be confident it is not simply tracking cyclical effects or the impact of two key components of required rate of return.[26]

In every model, trace test statistics indicate the existence of only one significant long-run relationship (cointegrating vector) and reject the null hypothesis of no significant long-run relationship between cap rates, required rates of return, expected rent growth, and capital availability. In addition, in every case the required rate of return has a positive and statistically significant relationship with cap rates, with magnitudes not far from the one-for-one theoretical effect. Nevertheless, the long-run coefficients on the real required rate of return are significantly statistically different from one, but this may owe to a measure issue about expected rent growth.

As expected, expected rent growth and capital availability each generally has a negative and significant estimated relationship with cap rates. Although theory does not imply a magnitude for the coefficient on capital availability, the size of the estimated coefficients on expected rent growth are smaller than what theory suggests. However, this is a common finding in related studies, suggesting that expectations of future rent growth are hard to precisely form or measure, or that some of the effect may be implicitly embedded in the estimated coefficient on required rates of return. If the latter is true, then part of the negative implied effect of expected

[26] In other runs not shown, we replaced the RERC capital availability index with the diffusion index of changes in bank credit standards for commercial real estate loans from the Federal Reserve's Senior Loan Officer Survey. (This diffusion index has a unit root.) The model fits and error-correction properties of the cap rate models were worse, likely reflecting three relative shortcomings of the Fed series. First, it tracks the relative change in, not the level of, credit availability. Second, there is a break in 2013q4, before which the Fed asked about credit standards on overall CRE loans and after which it only asked about three subcategories Third, unlike RERC data, Fed data do not track the availability of other finance, e.g., CMBS, which varies with changes in information costs and regulatory capital arbitrage (Penacchi, 1988; Wilcox, 2012).

rent growth would not be reflected in the magnitude of long-run coefficient on expected rent growth, reducing it below unity in absolute magnitude. In addition, this effect would also tend to lower the estimated coefficient on required rates of return below unity by combining the positive required return effect on cap rates with a negative implied effect of expected rent growth. This explanation is consistent with the magnitudes of our long-run coefficient estimates on both the required rate of return and the expected growth rate of rents.

Finally, from a broader finance perspective, the results are broadly consistent with the view that asset valuations are more reflective of shifts in the discount factor (required rate of return) rather than in cash flows, a theme following the seminal work of Campbell and Shiller (1988) on stock price movements. This interpretation is consistent with the fact that in the vector-error correction framework used, which allows for feedbacks among all of the long-run variables, the required rate of return is weakly exogenous to cap rates, which are not weakly exogenous to the required rate of return. This finding implies that risk premia and real Treasury rates drive cap rates in the long-run, and not the converse. Consistent with these results, it is reassuring that broad swings in the implied estimated long-run equilibrium relationships line up well with swings in actual cap rate ratios, as illustrated in Figure 8.[27]

IVc. What Drives CRE Cap Rates in the Short-Run?

Frictions that give rise to partial adjustment (e.g., transactions costs) imply the estimated long-run relationships should help explain short-run movements in cap rates in the VECMs. The lower panel of *Table 2* reports the results from eight cap rate change models. Models 1 through 8 include an error-correction term, EC_{t-1}, equal to the gap between actual cap rates and the equilibrium rate implied by corresponding long-run relationship reported in the upper panel of *Table 2*. When the actual exceeds the equilibrium cap rate in the prior quarter, long-run equilibrium implies a tendency for the cap rate to fall in the subsequent quarter, implying a negatively signed coefficient on EC_{t-1}.

Consistent with this implication, the error-correction term is negative and highly statistically significant in each model. Cap rate changes are generally increasing in required rates of return and decreasing in capital availability and expected rent growth. For the odd-numbered models using the raw capital availability index, the quarterly speeds of adjustment range between 40 and 62 percent across the four property types. The estimated speeds range from 47 to 72 percent when using the adjusted capital availability index. These coefficient estimates imply that following a shock to long-run fundamental determinants, cap rates almost

[27] For example, in the case of CBD office space, the estimated equilibrium relationship from Model 1 in Table 2 tracks the actual cap rate series well (Figure 8), with a tendency for the equilibrium cap rate to slightly lead the actual, consistent with the error-correction framework used.

fully adjust two to three quarters later, which seems reasonable for an asset whose sale entails sizable transactions costs and which is not as homogenous as highly liquid securities.

The only additional short-run variable, *ΔVIX*, has the expected positive sign, implying greater uncertainty raises cap rates. The estimated positive effect of lagged *ΔVIX* is statistically significant in six of eight short-run cap rate models. The fits are reasonable for models of first differences, ranging from 22 to 44 percent, and are higher for the more homogenous CBD office market (between 42 and 44 percent) than for the more heterogeneous retail mall market. This may be due to other cyclical effects on consumption that affect retail markets, and to the rising and hard-to-track impact of e-commerce on retail mall valuations.

Using the office space results from Model 1 in *Table 2*, the comprehensive impulse responses of cap rates to upward, permanent shifts in required rates of return and capital availability include both the reaction of cap rates to the $t-1$ first difference terms in each and the error-correction to a new equilibrium long-run level. As shown in *Figure 9*, a 1 percentage point upward shift in the required rate of return, from a combination of a 1 percentage point rise in the risk premium or real Treasury rate, pushes cap rates up by more than 50 basis points after 2 quarters and more than 60 basis points after 3 quarters.

A one percentage point rise in the index of capital availability (see *Figure 10*) lowers the cap rate by 6 basis points after two quarters and 10 basis points after four quarters, implying that one-half and three-fourths of the adjustment occurs in two and four quarters. These changes are meaningful because the capital availability index fell by 4 index points during the Long-Term Capital Management fund-Russian Default Crisis of 1998 and 7 points from 2006-09.

IVd. Robustness Checks on What Drives CRE Cap Rates

As reported above, the cap rate results are robust to the use of a capital availability index that is adjusted for cyclical factors and for swings attributable to movements in the general risk premium and the real riskless rates. Also, the models were rerun over the same sample period substituting PWC for RERC data on cap rates and required rates of return. Warehouse models could not be estimated as PWC data are available only since 2002. Since the PWC survey does not ask about capital availability, the RERC index is used.

The PWC survey provides expected rent growth estimates; however, the responses were much more variable and seemingly much more cyclical than those from the RERC survey, in which respondents are more clearly asked rent growth expectations over a longer-run horizon. Consistent with this view, there was stronger evidence of a unit root in the RERC expected rent growth series than in the corresponding PWC series, for which the level of expected apartment rent growth was stationary. Therefore, the corresponding RERC rent growth series were used in place of the PWC rent growth series.

For office and retail mall properties, the $t-2$ rather than the $t-1$ quarter lag of ΔVIX is included in the short-run PWC models. The lags used to identify the cointegrating vectors also differed from the RERC models. For apartment properties, four additional short-run controls were needed to obtain apartment PWC cap rate models with good cointegration properties, clean residuals, and sensible estimates. Three of these additional variables capture the spillover effects on rental markets of government efforts to aid owner-occupied housing during the recent crisis.[28]

As reported in *Table A1* of the Appendix, similar qualitative results were obtained from estimation of the PWC cap rate models. Unique and significant cointegrating vectors were identified in which required rates of return had positive and significant long-run coefficients, while capital availability and expected rent growth each had a negative and significant long-run coefficient in every case. In the short-run models, the error-correction terms were significant with the expected signs, indicating that between 26 and 34 percent of the gap between actual and equilibrium cap rates was eliminated in the next quarter. In five of the six models, the $t-2$ lag of ΔVIX had a significant and as expected, positive coefficient. Across the six specifications, the models were able to explain 35 to 84 percent of the variance in short-run cap rate changes. Overall, our results are robust to the use of PWC data in place of RERC data.

IVe. What Drives CRE Risk Premia in the Long-Run?

In the long-run, equilibrium risk premia should be increasing in the general risk premium (the Baa/10-year Treasury rate) and the stringency of regulatory capital requirements. The latter implies a positive coefficient on the effective regulatory capital requirement (*RegCap*) but a negative estimated coefficient on the regime dummy for the short period of liberalized capital regulation (*BaselSEC*=1). *BaaTR* and *RegCap* are included in the estimated cointegrating vectors reported in the upper panel of *Table 3*, where two models are presented for each of the four property types. In *Table 4*, *RegCap* is replaced by *BaselSEC*.

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[28] One was the national mortgage settlement of March 2012, under which private lenders agreed to provide mortgage assistance to troubled home-owners (mainly in the form of debt write-downs or lowering mortgage interest rates), which effectively lowered the demand for rentals and created risk for multi-family properties. The dummy variable *NatMort* equals "1" in 2012q3 to control for the upward pressure placed on apartment risk premiums, and its $t-1$ lag was included to control for the partial retreat of this upsurge in 2012q4 when there was less uncertainty about how much risk the settlement would actually pose. The t lag of *NatMort* is significantly positive, while its $t-1$ lag is significantly negative. Another binary variable for unusual federal actions on housing is *HomeTaxCred*, which controls for the imposition of an $8,000 tax credit for first-time home-buyers in 2009q1 (*HomeTaxCred*=1) and the expiration of that tax credit in 2010q3 (*HomeTaxCred*=-1). When it was created, the tax credit likely created more risk to apartment properties by lowering the appeal of continuing to rent, and its expiration arguably reversed that risk in risk. Consistent with this interpretation, *HomeTaxCred*, is significant and positive. Finally, a dummy for the Long-Term Capital Management and Russian default episode of 1998q3 (*RussDef* =1 that quarter, 0 otherwise) is included.

In *Table 3*, the odd numbered models include no extra short-run variables beyond the EC term and lagged first differences of the level variables in the cointegrating vectors. The even-numbered models include a common set of additional short-run variables, including the $t - 1$ lag of *ΔVIX*, the quarter t and $t - 1$ lags of the growth rate of the index of leading economic indicators (*LEIGR*), and the variable for the federal government shutdown in late 2013 (*GovShut13*).

In every model in *Table 3*, a unique and significant cointegrating vector was identified, rejecting the null hypothesis of no significant long-run relationship between CRE risk premiums, general bond risk premiums, and trends in regulatory capital regulation. Furthermore, as expected, the general market risk premium has a positive and statistically significant relationship with risk premiums,[29] as does the stringency of regulatory capital requirements. The addition of controls to the short-run models has little effect on the estimated long-run coefficients. The implied estimated long-run equilibrium relationships line up well with actual risk premiums in Figure 12, also reflecting the strength of the long-run estimated relationships.[30]

IVf. What Drives CRE Risk Premiums in the Short-Run?

The lower panel of *Table 4* reports estimation results from eight models of the change in risk premiums. As with the cap rate models, the error-correction term is negative and statistically significant in each model, implying that risk premiums tend to fall when the actual exceeds the equilibrium premium in the prior quarter. Error-correction coefficients imply that 28 to 60 percent of the gap between actual and equilibrium premiums closes after one quarter.

The added short-run variables also are significant with sensible signs. The estimated coefficient on Δ*VIX* is significant with the expected positive sign in every even-numbered model, indicating a tendency for CRE risk premiums to increase with general market uncertainty. The coefficient on the dummy for the impact of the government shutdown of 2013 has the expected negative effect, and is significant in three of four models. As expected, the quarter t growth rate in the leading economic indicators has a negative and highly significant sign, suggesting a counter-cyclical pattern of risk premiums. The time t-1 lag is significant with the opposite sign, perhaps, reflecting that CRE risk premia tend to overreact to signs of an improving economy, with much of the effect unwinding in the following quarter. Across the four property types, the addition of the four short-run factors raises the adjusted R-square statistics by 19 to 29 percent.

IVg. Robustness Checks on What Drives CRE Risk Premiums

In addition to the long-run risk premia estimates being robust to the inclusion of additional short-run variables, the models are robust in other ways. *Table 4* reports results from

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[29] This is consistent with Chervachidze, Costello, and Wheaton (2010) and Chervachidze and Wheaton (2013).

[30] For example, commercial office risk premiums are well tracked by the implied equilibrium relationship from model 1, which, as expected, tends to slightly lead the actual in Figure 12.

substituting the regime dummy for regulatory liberalization (*BaselSEC*) for *RegCap* in odd-numbered models, with the even-numbered models from *Table 3* included for convenience of comparison. Each model includes the statistically and economically significant set of four short-run variables.

In every case, a significant and unique cointegrating vector is identified, with the odd-numbered models in *Table 4* implying that liberalizing capital requirements boosts risk-taking in the form of lower risk premiums, as expected. As in the even-numbered models, the general bond risk premium has a positive and highly significant relationship with CRE risk premiums.

In the models of the quarterly change in risk premiums, the error-correction term is highly significant with the expected negative sign. Moreover, all of the extra short-run variables have similar estimated effects as in the corresponding even-numbered models that use *RegCap* instead of *BaselSEC*. For two of the property types, the *RegCap* models have notably better fits, while the converse is true for only one property type and the model fit is similar for apartments. In three of four cases, the estimated speed of adjustment is faster for the models using *RegCap*. The models using *RegCap* yield estimates with clean residuals for each property type, whereas this was only the case for two property types using *BaselSEC*. Overall, the results slightly favor the more calibrated measure of capital requirement stringency over the regulatory shift dummy. Nevertheless, the results are robust to using an alternative control for regulatory trends.

The robustness of the risk premium results was also examined using PWC data on risk premiums in lieu of the RERC data with the other variables for office, apartment, and retail mall properties. As shown in *Table A2* of the Appendix, significant cointegrating vectors were identified in every model, with highly significant and sensibly signed effects on general bond risk premiums and variable for capital requirement stringency. In the short-run models, the error-correction terms were highly significant with negative signs and plausible magnitudes of coefficients. And the short-run variables had similar effects as in models estimated with RERC data. The only notable difference is that the model fits were better in the models using RERC risk premiums. This may reflect that the RERC survey participants are more homogenous than the PWC sample, which is broader in the number of respondents surveyed.

IVh. The Roles of Long-Run Factors in Driving Swings in Cap Rates and Risk Premiums

One benefit of estimating error-correction models is that the long-run relationship can be used to illustrate the relative importance of different long-run determinants in driving CRE cap rates and risk premiums. To this end, *Figures 11* and *12* use the long-run relationships in model 1 from *Table 2* and 2 from model 4, respectively, to decompose the long-run movements in the estimated equilibrium levels of office real cap rates and risk premiums.

As *Figure 8* displays, office cap rates fell in the mid-2000s, then returned to levels seen in the 1990s, and more recently fell. The green line in *Figure 11* shows that swings in expected rents contribute very little to swings in equilibrium cap rates. The gap between the light blue and green lines implies that changes in capital regulation slightly lowered cap rates in the mid-2000s and helped push them up slightly following the passage of Dodd-Frank. More prominent roles were played by swings in required rates of returns.

The required rate of return can be decomposed into a real Treasury component (*Figure 8*) and a risk premium (*Figure 7*) component. The estimated contributions of each to office cap rates can then be calculated by multiplying each by the estimated long-run coefficient on the required rate of return (Model 1 in *Table 3*). The red line in *Figure 11* indicates that the compression of cap rates in the mid-2000s was mainly due to a drop in CRE risk premiums. Moreover, the sharp reversal in CRE risk premiums during 2008-09 largely reflects a spike in general risk premiums. In more recent years, risk premiums are contributing relatively less to cap rate movements. The gap between the red and light blue lines reflects the contribution of real Treasury rates to risk premiums. These declined during the Great Recession when riskless rates fell in response to a flight to quality and the easing of monetary policy. Most recently, unusually low real Treasury bond yields have been the main factor in compressing cap rates to low levels, consistent with concerns that easy monetary policy may lead to excessive highs in asset prices (Stein, 2013). Hence, in contrast to the mid-2000s when low risk premia compressed cap rates, recent cap rate compression owes more to unusually low real riskless interest rates.

Using commercial office space data, swings in equilibrium CRE risk premiums can be similarly decomposed using Model 2 from *Table 4*. As illustrated by the red line in *Figure 12*, the lowering of effective capital requirements on CRE assets in the mid-2000s is associated with notably reduced CRE risk premiums, which was compounded by a narrowing of general bond risk premiums—as implied by the narrowing of the gap between the blue and red lines in the mid-2000s. The sharp upturn in risk premiums in 2008-09 appeared to be a general market phenomenon, as indicated by the estimated contribution of very high Baa-Treasury spread (the blue line). Currently, risk premiums are near their average over the sample period.

When considering the impact of regulation and general bond risk premiums on CRE risk premiums, a richer interpretation of the boom, bust, and recovery in cap rates emerges. The unsustainable compression of cap rates in the mid-2000s resulted mainly from a narrowing of CRE risk premiums that stemmed from declines in capital regulatory stringency and in general risk premiums, as reflected in the Baa/10-year Treasury spread. Greater capital availability played a minor contributory role.

The reversal of cap rates during the Great Recession resulted mainly from a steep rise in risk premiums driven by a surge in general risk premiums, as tracked by *BaaTR*. This increase outweighed falling real Treasury rates until 2010. By at least partially reversing the effective reduction of capital regulations of the mid-2000s, Dodd-Frank has helped keep CRE risk premiums near their longer-run average, as has the normalization of the Baa-Treasury bond yield spread. Consequently, the unusually low cap rates of recent years primarily owes to unusually low real Treasury bond yields according to model estimates. By implication, some upward pressure on cap rates may emerge when Treasury yields eventually normalize.

V. Conclusion

Although last decade's boom and bust in commercial real estate (CRE) prices was at least as large as that in residential house prices and had a larger effect on bank failures, it has not been the subject of as much study. We address this research gap by estimating cohesive models of short-run and long-run movements in capitalization rates across four core types of commercial properties: apartments, industrial warehouse, central business district (CBD) office properties, and regional (retail) malls.

Based on the Gordon Growth Model, a classical property valuation approach implies that capitalization rates should be positively related to investors required rates of return and negatively related to expected rent growth, two variables that are notoriously difficult to find proxies for. We finesse this problem by using a unique data set from the Real Estate Research Corporation (RERC). This dataset includes survey responses of active participants in commercial real estate markets on these key series. We supplement these variables with measures of access to capital, including the impact of commercial mortgage-backed securities and the regulation of holders of these securities. We find evidence of statistically strong long-run (cointegrating) relationships in which cap rates are positively related to investors' required rates of return and negatively related to their assessments of capital availability and the expected growth rate of rental income. These commercial real estate findings parallel those of Duca, Muellbauer, and Murphy who estimate models of house price to rent ratios using a credit-augmented approach.

Another important feature of our findings is that these estimated long-run relationships slightly lead and line up well with long-run trends in actual cap rates, bolstering the credibility of our estimates. Furthermore, short-run changes in cap rates are strongly driven by a tendency for actual cap rates to move toward their long-run equilibrium and short-run models have reasonably good fits. Strong evidence of equilibrium- (error-) correction in the short-run is consistent with the presence of frictions and transactions costs in commercial real estate markets. All of these results are robust across the four major property types and to substituting data from PWC for RERC measures of cap rates and real required returns.

Our empirical framework allows us to empirically decompose which factors were associated with the large jump in CRE prices and fall in cap rates during the boom of the mid-2000s, as well as the jump in cap rates during the bust of 2008-10. Results indicate that these were partly driven by an upswing and then downswing in the availability of capital for CRE investment, but mainly resulted from sharp declines in required rates of return during the boom years, followed by pronounced increases during the bust phase. By deducting long-term Treasury yields from required rates of return, we are able to attribute swings in the latter to large shifts in risk premia, which we, in turn, are able to successfully model in both the short- and long-runs as positively related to swings in general corporate risk premiums and the stringency of capital requirements on commercial and investment banks for investing in CRE.

Using decompositions of estimated long-run equilibrium factors, our results imply that at least a portion of the decline in CRE risk premiums during the boom was linked to weaker regulatory capital requirements that enabled banks and other regulated financial firms to take on more risk and push market risk premia lower. This exogenous regulatory change also may have signaled to other CRE market participants that CRE's risk, relative to stocks, bonds, and other assets, had declined. The return to normal risk premia levels in 2009 and 2010 was first driven by a steep rise in general risk premia, as tracked by the Baa-10-year Treasury yield spread, and later by a tightening of effective capital requirements on CMBS resulting from Dodd-Frank. To a large extent this shift reflects how CRE prices are vulnerable, via a CMBS or capital market channel, to shocks to liquidity and shadow bank finance emphasized in recent research (e.g., Gennaioli, et. al, 2013, Gorton and Metrick, 2012, and Luck and Schempp, 2014). Our results also imply that the recovery in CRE prices and declines in required rates of return since 2010 have been mainly driven not by unusually low risk premiums, but rather by declines in real Treasury yields to unusually low levels. By implication, CRE prices may come under some pressure when Treasury yields eventually normalize unless there is an unusual, accompanying fall in risk premiums, which are currently near historical average levels.

From a broader asset pricing perspective, our findings have several important implications. First, shifts in risk premiums, risk-free rates, and capital availability significantly affect property prices in sensible and quantifiable ways. Second, by using a comprehensive, yet cohesive estimation approach, prices of less liquid assets and the risk premiums on them can be successfully gauged by a mixture of general and sector specific factors and be sensibly interpreted as arising from particular combinations of short- and long-run factors, consistent with how market participants generally perceive market forces. Third, our study finds that regulatory limits on leverage may help limit asset price booms by preventing risk premiums demanded by investors from falling too far for affected asset classes. This finding has important implications for the channels through which macro-prudential regulation may or may not be effective in limiting unsustainable increases in asset prices. Finally, swings in general risk premiums, such as the Baa-10 year Treasury spread, could still have important effects that regulations may or may not be able to limit. By implication, well-designed macro-prudential policy may limit—but not eliminate—the impact of shifts in risk premiums on asset prices and their indirect effects on the macro-economy and financial stability.

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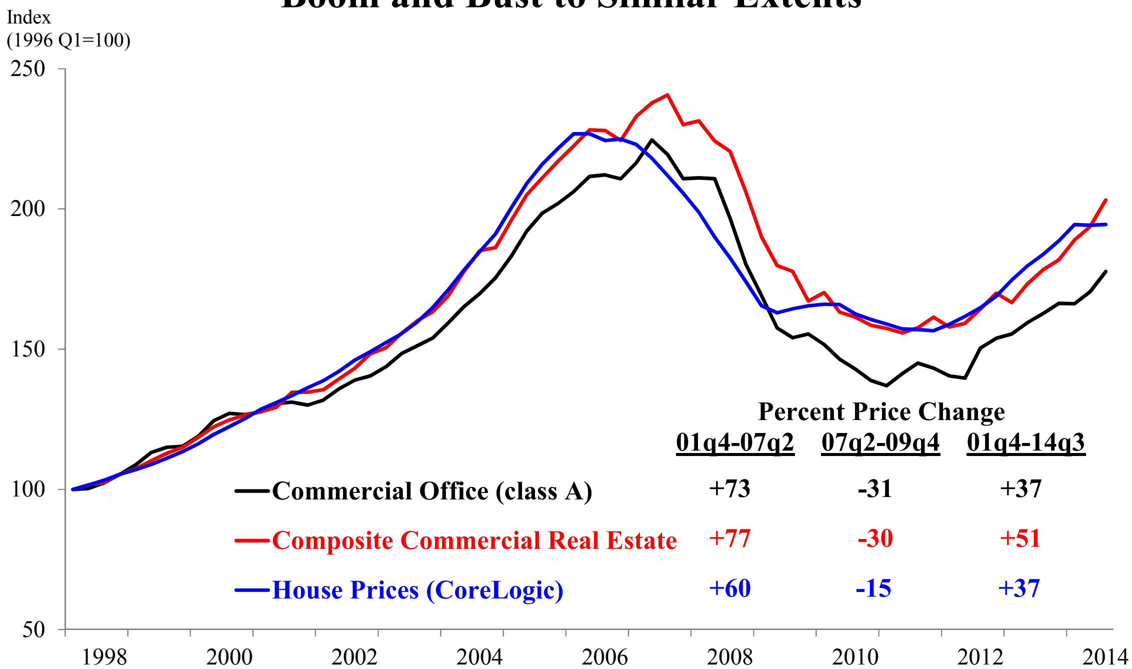
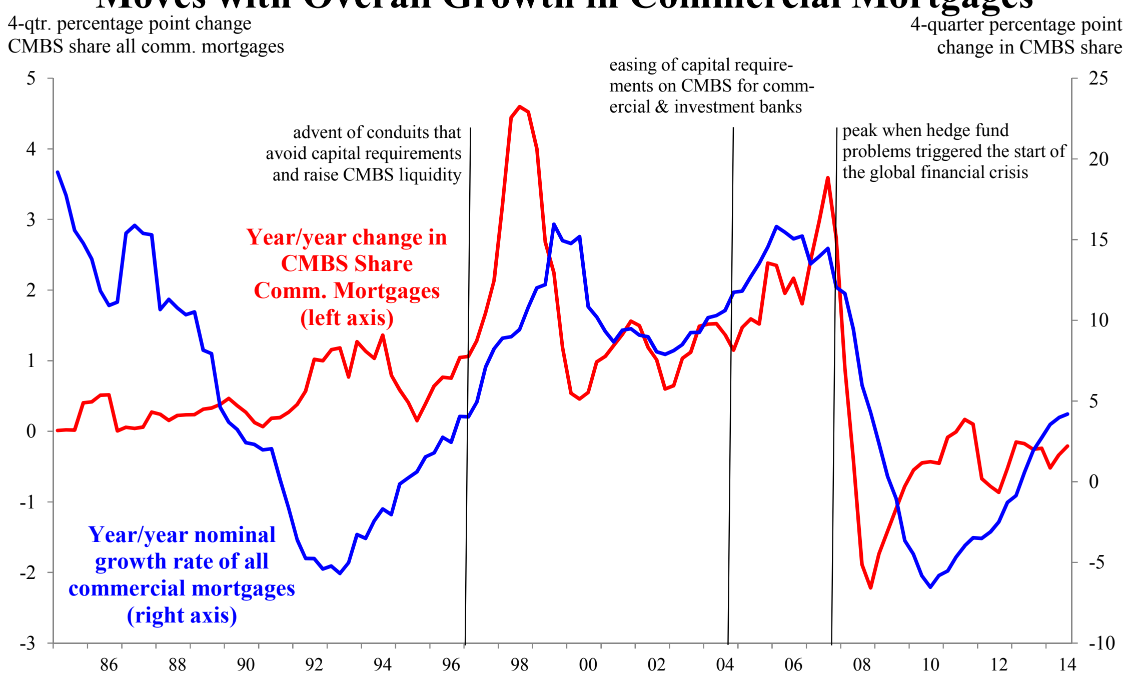
Figure 1: U.S. House and Commercial Real Estate Prices Boom and Bust to Similar Extents



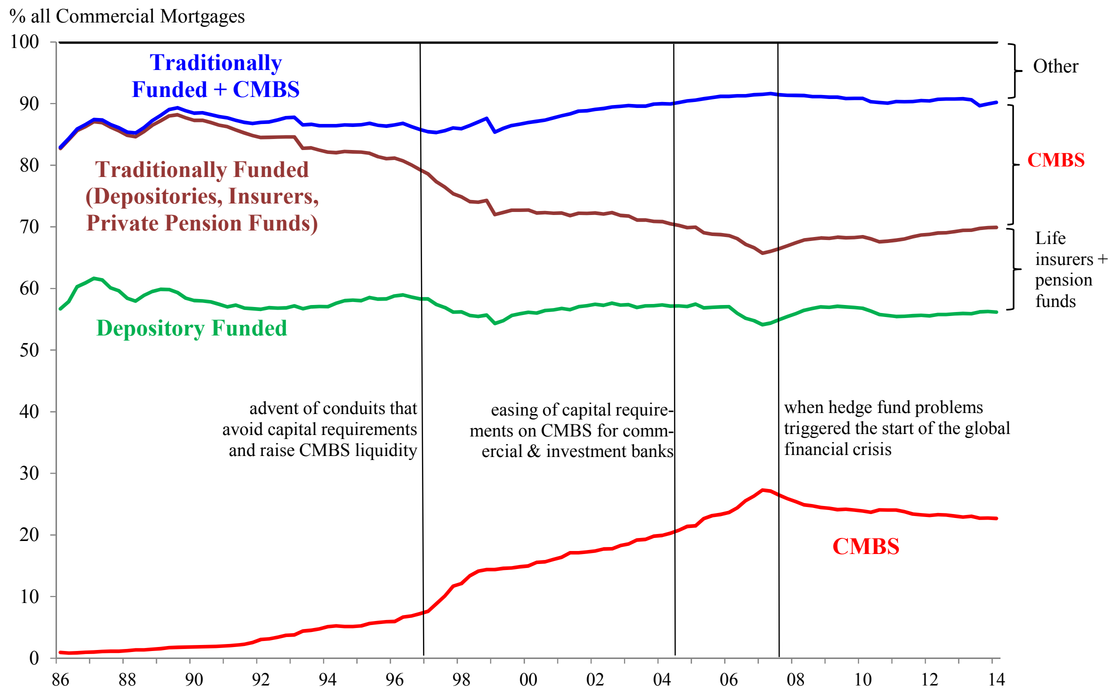
Sources: CoStar equal (sales unit) weighted repeal sales prices, CoreLogic (equal sales unit-weighted) repeat sales, and authors' calculations.

Figure 2: Change in CMBS Share of Commercial Mortgages Moves with Overall Growth in Commercial Mortgages



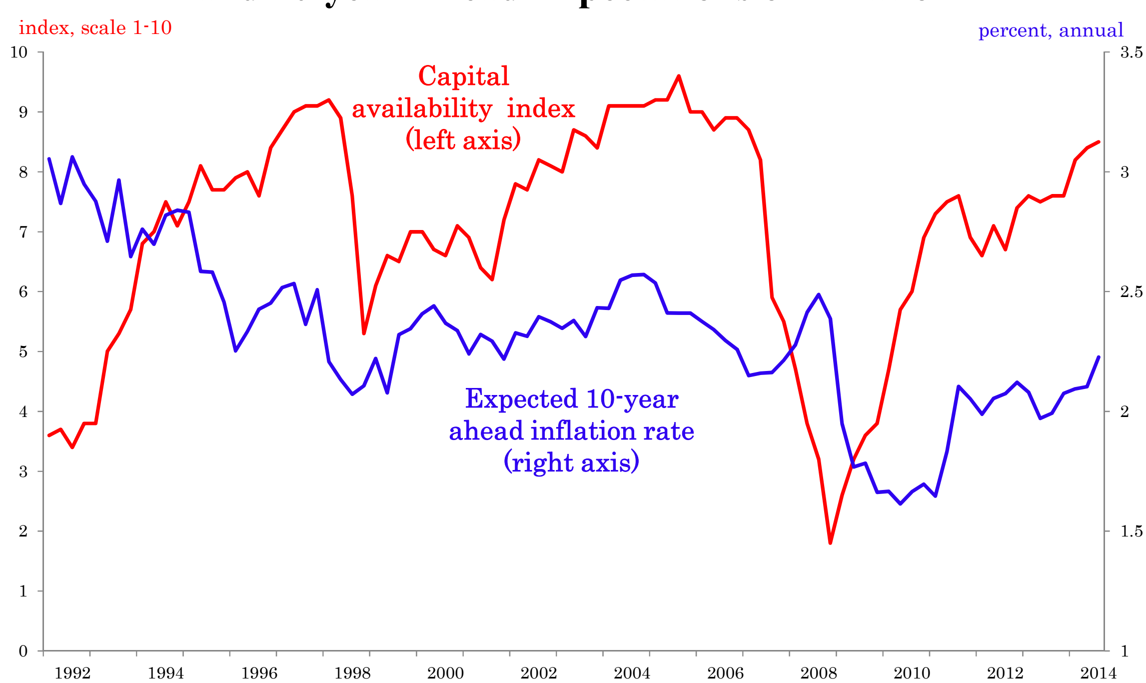
Sources: Flow of Funds and authors' calculations. CMBS adjusted for 130.4B reclassification of CMBS as REITS in 2013.q2.

Figure 3: The Evolution of How Commercial Mortgages Are Held



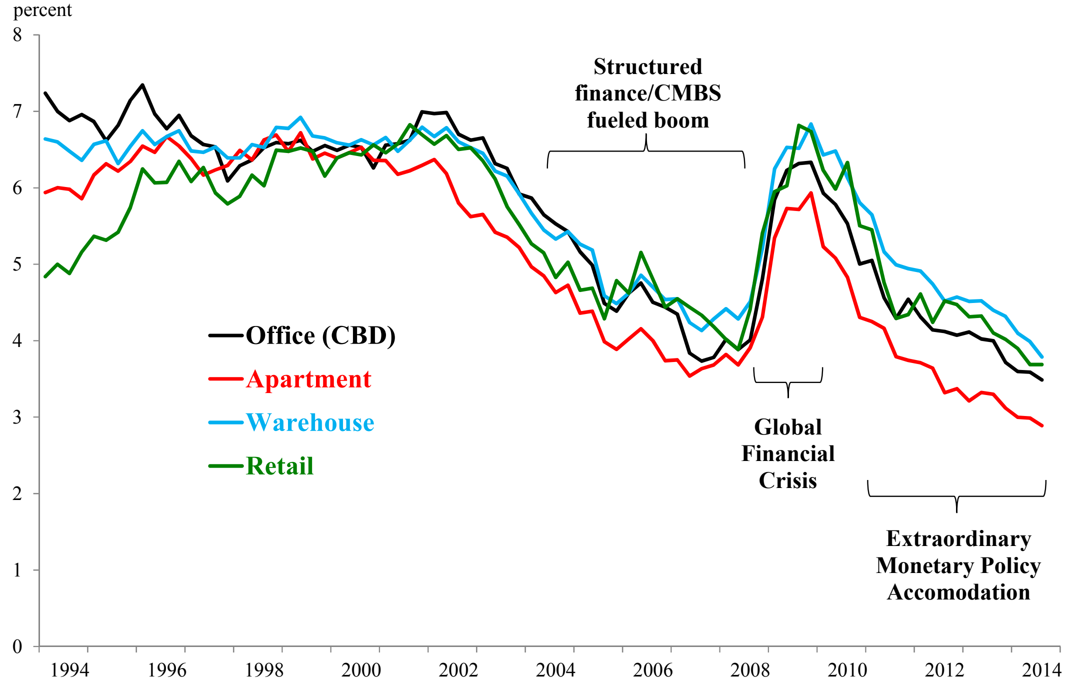
Source: Flow of Funds and authors' calculations. CMBS and "Other" adjusted for 130.4B reclassification of CMBS as REITS in 2013.q2 Other includes REIT holdings, *inter alia*.

Figure 4: Index of Capital Availability and 10-year Ahead Expectations of Inflation



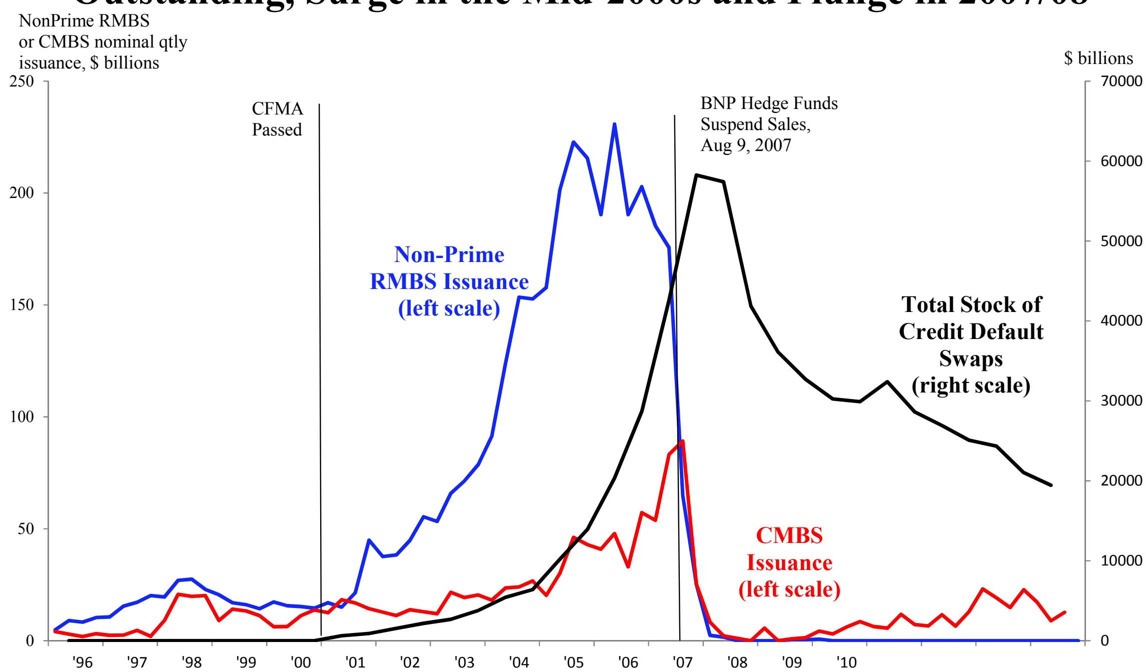
Sources: RERC and Federal Reserve Board quarterly model of the U.S. economy.

Figure 5: Real Capitalization Rates for Commercial Real Estate



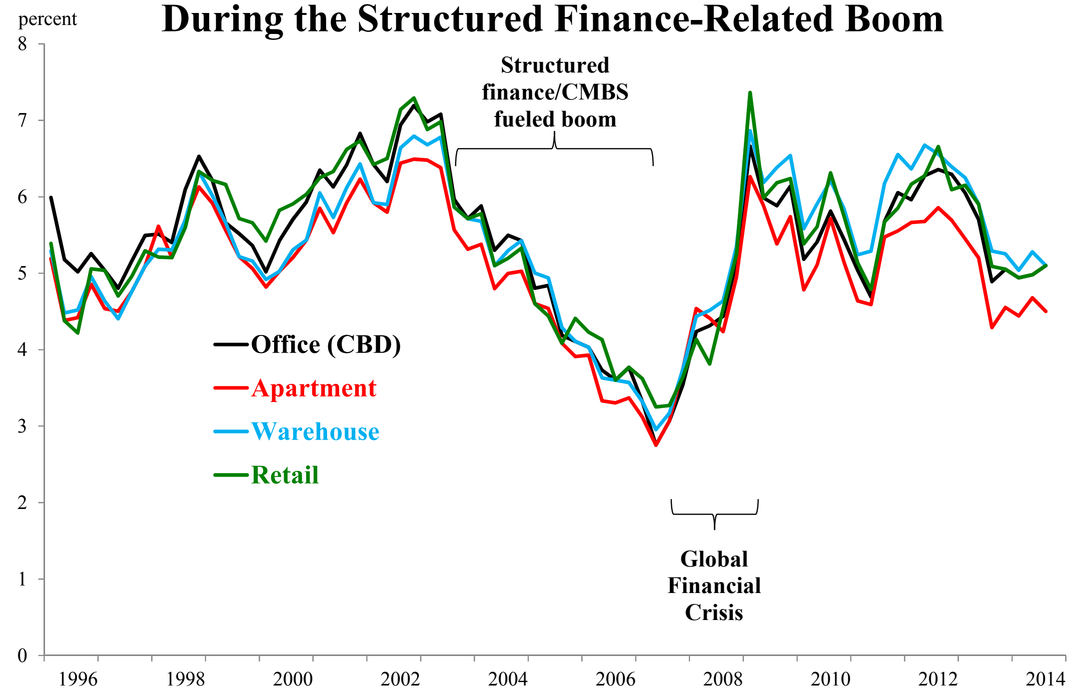
Sources: RERC value-weighted cap rates, Federal Reserve, Federal Reserve Board Model 10 yr. expected inflation, and authors' calculations.

Figure 6: CMBS and NonPrime RMBS Issuance, with CDS Outstanding, Surge in the Mid-2000s and Plunge in 2007/08



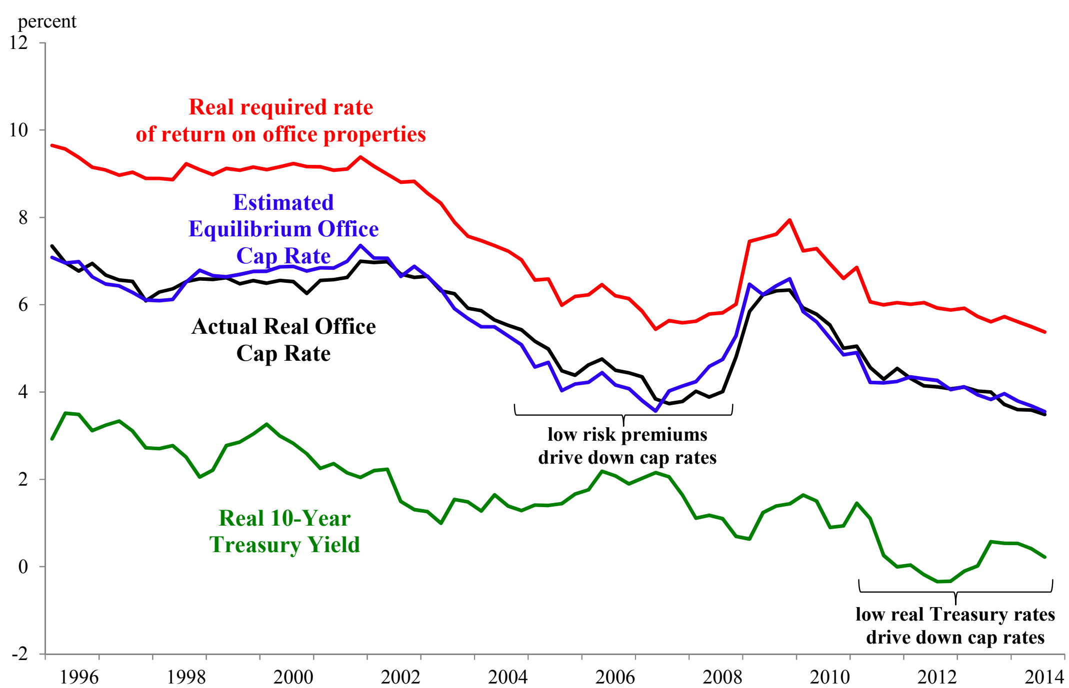
Sources: *Inside Mortgage Finance*, SIFMA, BIS, ISDA, and authors' calculations.

Figure 7: Risk Premia on Commercial Real Estate Collapse During the Structured Finance-Related Boom



Sources: RERC value-weighted cap rates, Federal Reserve, Federal Reserve Board Model 10 yr. expected inflation, and authors' calculations.

Figure 8: Estimated Equilibrium Tracks Real Office Cap Rate



Sources: RERC requried rates of return less 10-yr. expected inflation, Federal Reserve, and authors' calculations.

Figure 9: The Reaction of Real Office Capitalization Rates to a 1 Percentage Point Rise in the Real Required Rate of Return

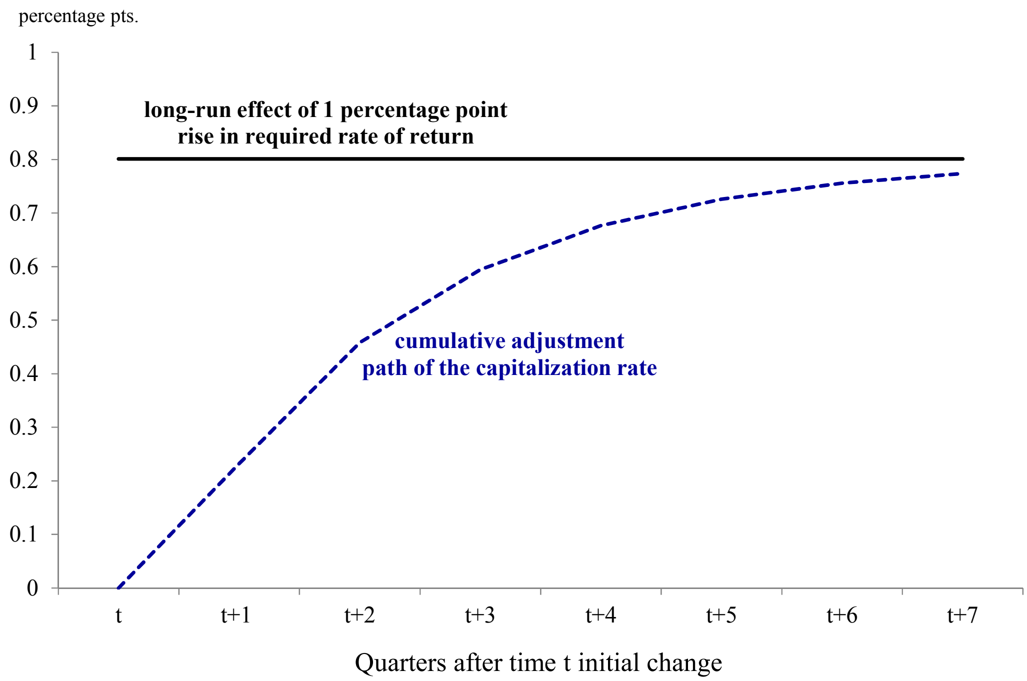


Figure 10: The Reaction of Real Office Capitalization Rates to a 1 Point Rise in the Index of Capital Availability

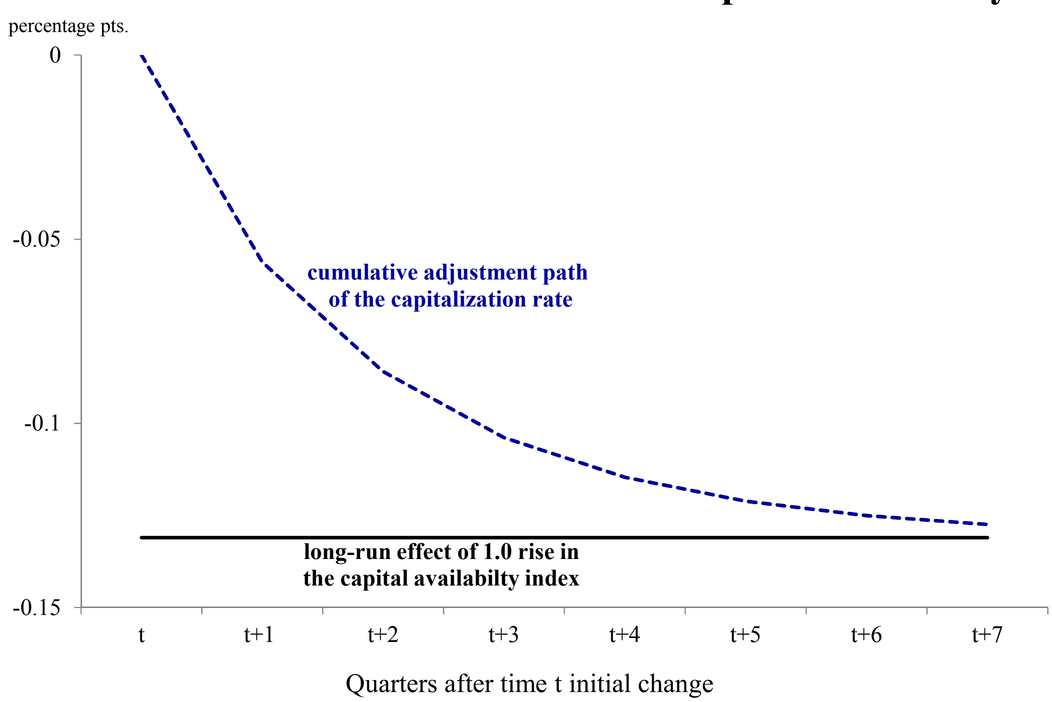
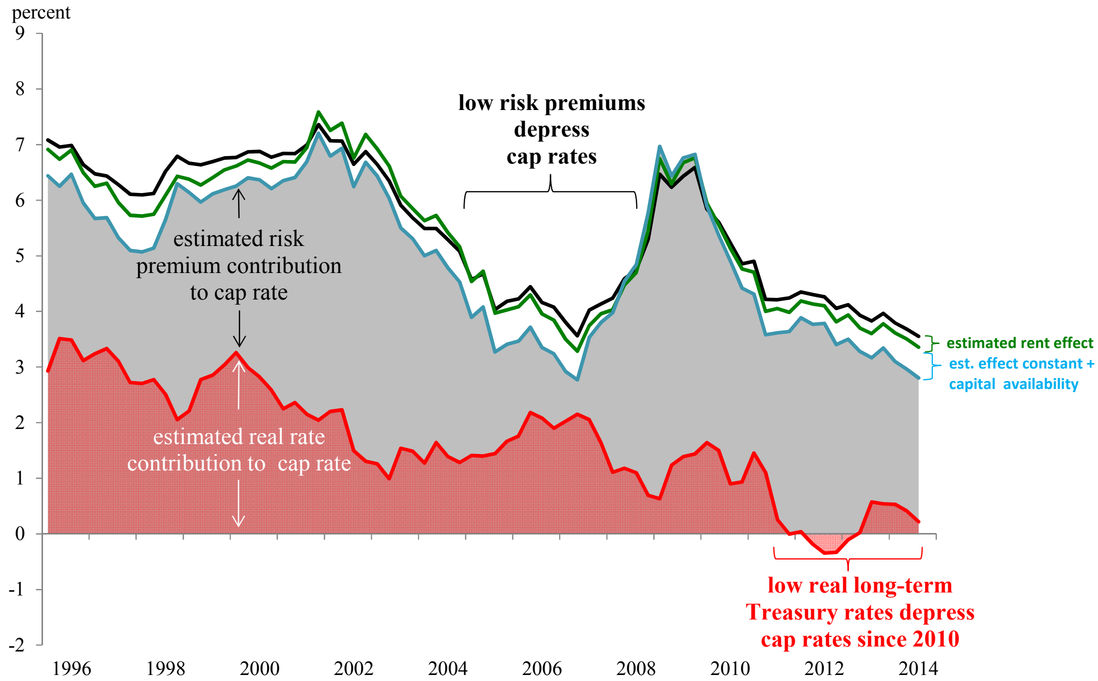
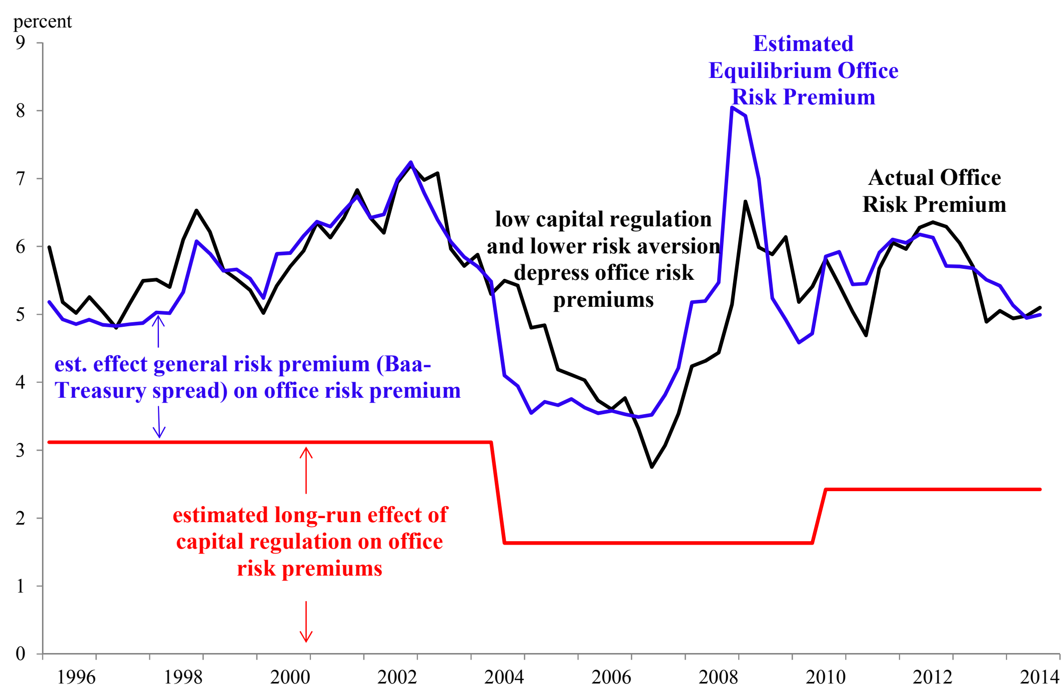


Figure 11: Decomposition of the Real Office Capitalization Rate



Sources: RERC value-weighted cap rates, Federal Reserve, Federal Reserve Board Model 10 yr. expected inflation, and authors' calculations.

Figure 12: Decomposition of the Office Risk Premium



Sources: RERC requried rates of return less 10-yr. Treasury yield, Federal Reserve, and authors' calculations.

Table 1: Descripriive Statistics-Selected Variables (1996:Q1 - 2014:Q3)								
					Serial Correlation		Unit Root Tests[1]	
	Mean	Std Dev	Min	Max	Levels	Changes	Levels	Changes
Dependent variables								
RERC real capitalization rates:								
Regional malls	7.7	1.0	5.8	9.1	0.95	-0.09	-1.98 (0)	-8.05** (0)
CBD office	7.7	1.2	5.6	9.6	0.98	0.44	-2.40 (1)	-6.04** (0)
Industrial warehouse	7.9	1.0	5.9	9.2	0.98	0.37	-2.03 (1)	-5.86** (0)
Apartments	7.2	1.3	5.0	9.1	0.99	0.24	-2.70 (2)	-6.85** (0)
RERC required risk premiums								
Regional malls	5.4	1.0	3.0	7.4	0.86	-0.06	-2.27 (0)	-9.17** (0)
CBD office	5.4	1.0	2.8	7.2	0.89	0.08	-2.08 (0)	-7.88** (0)
Industrial warehouse	5.4	0.9	3.0	6.9	0.89	0.09	-1.98 (0)	-7.87** (0)
Apartments	5.0	0.9	2.8	6.5	0.89	0.05	-2.20 (0)	-8.16** (0)
LR risk premium and cap rate determinants								
RERC real expected rental growth rate:								
Regional malls	2.4	0.7	0.6	3.6	0.82	-0.25	-3.11 (0)	-11.24**(0)
CBD office	2.6	0.9	0.7	4.2	0.88	-0.20	-2.06 (0)	-10.54**(0)
Industrial warehouse	2.5	0.7	0.8	3.7	0.90	-0.12	-1.99 (0)	-9.81** (0)
Apartments	2.8	0.6	1.2	3.6	0.91	0.20	-1.99 (0)	-7.64** (0)
RERC real required IRR/discount rate:								
Regional malls	9.7	1.5	7.6	12.0	0.97	-0.20	-2.60 (2)	-4.68** (1)
CBD office	9.7	1.5	7.6	11.9	0.99	0.00	-1.67 (0)	-8.11** (0)
Industrial warehouse	9.6	1.3	7.6	11.4	0.98	0.02	-2.10 (4)	-3.97* (3)
Apartments	9.3	1.5	7.0	11.3	0.99	-0.05	-1.86 (0)	-8.83** (0)
Availability of capital	7.3	1.8	1.8	9.6	0.93	0.27	-1.97 (1)	-6.47** (0)
Adjusted availability of capital	10.1	1.4	6.5	11.8	0.92	0.15	-1.57 (0)	-7.31** (0)
Baa-10-year Treasury spread	2.5	0.8	1.5	5.6	0.87	0.25	-3.21 (1)	-6.62** (0)
Reg cap requirement-securitized mtg	5.3	2.8	1.6	8.0	0.95	0.00	-1.43 (0)	-8.54** (0)
Basel/SEC easing of cap. requiremen	0.32	0.5	0.0	1.0	0.93	0.00	-1.34 (0)	-8.56** (0)
PWC Real capitalization rates:								
Regional malls	5.6	0.8	4.3	6.8	0.94	0.27	-2.28 (1)	-6.41** (0)
CBD office	5.9	1.1	3.9	7.3	0.94	0.42	-2.96 (2)	-5.30** (0)
Apartments	5.1	1.3	3.3	6.8	0.96	0.63	-2.97 (1)	-4.00* (0)
PWC Required risk premiums								
Regional malls	5.9	1.1	3.7	7.7	0.92	0.16	-2.57 (3)	-7.30** (0)
CBD office	5.5	1.0	3.1	7.3	0.92	0.18	-1.78 (0)	-7.20** (0)
Apartments	5.5	0.9	3.5	7.1	0.91	0.23	-2.35 (1)	-6.79** (0)
PWC Real expected rental growth rate:								
Regional malls	0.3	0.7	-1.8	1.1	0.92	0.09	-3.54* (3)	-4.23**(3)
CBD office	0.0	1.4	-3.7	1.9	0.95	0.45	-3.99* (2)	-5.19**(0)
Apartments	0.2	0.9	-2.6	1.4	0.94	0.46	-3.57* (0)	-3.53* (1)
PWC Real required IRR/discount rate:								
Regional malls	8.0	1.1	6.2	9.4	0.95	0.38	-2.59 (2)	-4.68** (1)
CBD office	7.6	1.4	5.3	9.8	0.95	0.34	-2.59 (2)	-5.68** (0)
Apartments	7.6	1.3	5.7	9.4	0.96	0.55	-2.71 (1)	-4.54** (0)
Short-run control variables								
Change in VIX	0.002	6.0	-13.6	33.5	-0.09	-0.42	-8.13** (1)	
% Δ in leading economic indicators	0.003	0.02	-0.08	0.03	0.79	0.24	-3.53* (1)	

1. ADF test statistics inclusive of a time trend and constant; SIC lag in parentheses.

Table 2: Estimates of Real Capitalization Rates on Commercial Property

Long-Run Equilibrium: $\boldsymbol{CapRate_t = \alpha_0 + \alpha_1\, ReqRtn_t + \alpha_2\, ExpRentGrowth_t + \alpha_3\, CapAvail_t + \mu_t}$

Variables	Office		Apartment		Warehouse		Retail Malls	
Model No.	1	2	3	4	5	6	7	8
Const	0.560	0.887	-0.836	-0.513	0.606	1.061	1.088	2.207
$ReqRtn_t$	0.801**	0.773**	0.884**	0.887**	0.799**	0.830**	0.676**	0.669**
	(27.00)	(34.18)	(80.37)	(78.80)	(33.22)	(31.89)	(13.45)	(20.64)
ExpRent-	-0.225**	-0.192**	-0.038	-0.027	-0.100*	-0.163**	0.045	-0.331**
$Growth_t$	(4.20)	(4.54)	(1.44)	(1.05)	(2.29)	(3.47)	(0.33)	(3.67)
$CapAvail_t$	-0.131**	-0.107**	-0.056**	-0.075**	-0.114**	-0.149**	-0.261*	-0.169**
adj.: 2,4,6,8	(4.74)	(3.76)	(5.28)	(5.15)	(6.37)	(5.99)	(5.69)	(4.57)
unique coint.	Yes*	Yes*	Yes**	Yes**	Yes**	Yes*	Yes*	Yes*
vec. # lags	1	5	4	4	1	1	1	2
trace no vec.	50.41*	48.89*	64.88**	64.62**	54.48**	49.84*	50.61*	48.84*
trace only 1	23.82	27.69	29.32	29.08	23.45	20.00	25.05	25.28
Short-Run: $\boldsymbol{\Delta CapRate_t = \beta_0 + \beta_1 EC_{t-1} + \Sigma\beta_{2i}\,\Delta ReqRtn_{t-i} + \Sigma\beta_{3i}\,\Delta ExpRentGrowth_{t-i} + \Sigma\beta_{4i}\,\Delta CapAvail_{t-i} + EvRisk_t + \varepsilon_t}$								
EC_{t-1},	-0.397**	-0.465*	-0.621*	-0.725*	-0.565**	-0.476**	-0.411**	-0.696**
'adjust.speed'	(3.81)	(2.40)	(2.07)	(2.36)	(4.13)	(3.70)	(4.48)	(4.32)
ΔVIX_{t-1}	0.013**	0.017**	0.013**	0.011*	0.008^{+}	0.008*	0.009	0.015*
	(3.29)	(3.67)	(2.83)	(2.37)	(1.92)	(2.08)	(1.55)	(2.60)
$\Delta CapRate_{t-1}$	0.180	0.255	0.466^{+}	0.592*	0.359*	0.400*	-0.002	0.066
	(1.38)	(1.12)	(1.70)	(2.05)	(2.13)	(2.34)	(0.01)	(0.34)
$\Delta ReqRtn_{t-1}$	-0.086	-0.079	-0.256	-0.400	-0.257^{+}	-0.269^{+}	-0.066	-0.048
	(0.66)	(0.37)	(1.03)	(1.47)	(1.65)	(1.72)	(0.53)	(0.30)
Δ*ExpRent-*	-0.094	-0.040	-0.062	-0.105	-0.062	-0.068	0.058	0.270
$Growth_{-1}$	(1.43)	(0.45)	(0.58)	(0.97)	(0.80)	(0.84)	(0.65)	(2.30)
$\Delta CapAvail_{t-1}$	-0.004	-0.045	0.021	0.021	-0.008	-0.009	-0.015	-0.042
	(0.10)	(0.87)	(0.45)	(0.39)	(0.19)	(0.21)	(0.24)	(0.61)
Adj. R^2	0.435	0.416	0.357	0.318	0.416	0.377	0.222	0.265
S.E.	0.196	0.200	0.193	0.199	0.182	0.187	0.277	0.271
VEC Auto (1)	15.49	15.98	22.59	25.31	18.56	18.69	18.75	12.48
VEC Auto (2)	17.98	7.24	21.30	18.66	18.12	16.29	22.08	24.82
VEC Auto (4)	13.49	11.98	33.57**	24.85	20.77	23.14	14.33	11.67

Notes: (i) Absolute t-statistics in parentheses. ** (*) denotes significant at the 99% (95%) confidence level. (ii) Lag lengths chosen to obtain unique significant vectors with sensible coefficients and clean residuals. (iii) First difference terms of elements in the cointegrating vector lagged more than one quarter omitted to conserve space. (iv) Long-run: Maximum likelihood estimates of the long-run equilibrium relationship $CapRate_t = \alpha_0 + \alpha_1\, ReqRtn_t + \alpha_2\, ExpRentGrowth_t + \alpha_3\, CapAvail_t + \mu_t$ using a four equation system with (at most) one cointegrating vector.

(v) Short-run: OLS estimates of the speed of adjustment and short-run dynamics using the estimated equilibrium correction terms in (ii), $EC_{t-1} = CapRate_{t-1} - \alpha_0 - \alpha_1\, ReqRtn_{t-1} - \alpha_2\, ExpRentGrowth_{t-1} - \alpha_3\, CapAvail_{t-1}$

(vii) Adj,.*CapAvail* equals *CapAvail* minus the estimated effects of 2 lags in the change in the *GDPGap*, *BaaTR*, and *RTR* from this regression:
$CapAvail_t = 10.551 - .144\text{x}\Delta GDPGap_{t-1}^{+} - .279{*}\Delta\, GDPGap_{t-2}^{**} - 0.988\text{x}BaaTR10_t^{**} - .182\text{x}RTR10_t - .084\text{x}Dum07q3 - 1.133\text{x}Dum98q4$
t-stats. : (10.95) (1.48) (2.88) (5.32) (1.22) (2.42) (3.16) ρ=.929; adj.R^2.933

Table 3: Estimates of the Risk Premium on Commercial Property With and Without Short-Run Controls

Long-Run Equilibrium in Models 1-4: $RiskPrem_t = \alpha_0 + \alpha_1 BaaTR_{t-3} + \alpha_2 RegCap + \mu_t$

Variables	Office		Apartment		Warehouse		Retail Malls	
Model No.	1	2 ex.s-run	3	4 ex.s-run	5	6 ex.s-run	7	8 ex.s-run
Const	1.916	1.691	1.434	1.276	0.965	1.443	1.677	1.036
$BaaTR_t$	0.814**	0.950**	0.923**	1.057**	1.294**	1.256**	0.947**	1.210**
	(8.12)	(8.78)	(6.54)	(7.82)	(8.28)	(.7.92)	(9.04)	(8.06)
RegCap	0.271**	0.247**	0.242**	0.208**	0.217**	0.142**	0.263**	0.257**
	(11.58)	(10.60)	(6.17)	(6.31)	(5.53)	(4.15)	(10.62)	(7.38)
unique coint.	Yes**	Yes**	Yes**	Yes**	Yes*	Yes**	Yes**	Yes*
vec. # lags	3	5	1	2	2	5	3	4
trace no vec.	45.95**	39.64*	29.92*	31.35**	35.66*	38.78**	38.98**	30.37*
trace only 1	14.30	12.99	12.10	8.63	10.71	8.01	11.20	10.69

Short-Run: $\Delta RiskPrem_t = \beta_0 + \beta_1 EC_{t-1} + \Sigma\beta_{2i}\Delta RiskPrem_{t-i} + \Sigma\beta_{3i}\Delta BaaTR_{t-i} + \Sigma\beta_{4i}\Delta RegCap_{t-i} + \beta_6 X + \varepsilon_t$

	1	2 ex.s-run	3	4 ex.s-run	5	6 ex.s-run	7	8 ex.s-run
$EC_{t-1,}$	-0.571 **	-0.601**	-0.293**	-0.279**	-0.324**	-0.337**	-0.498**	-0.356**
'adjust.speed'	(5.12)	(4.35)	(3.10)	(2.97)	(4.07)	(2.98)	(3.78)	(3.35)
$\Delta RiskPrem_{t-1}$	0.163	0.322*	-0.078	-0.012	-0.027	0.076	-0.077	-0.042
	(1.31)	(2.29)	(0.62)	(0.10)	(0.22)	(0.58)	(0.57)	(0.36)
$\Delta BaaTR_{t-1}$	0.184	-0.240	0.254+	-0.215	0.201	-0.126	0.421*	-0.107
	(1.28)	(1.30)	(1.76)	(1.27)	(1.46)	(0.71)	(2.34)	(0.57)
$\Delta RegCap_{t-1}$	-0.068	-0.119*	-0.079	-0.067	-0.064	-0.069	-0.073	-0.053
	(1.33)	(2.29)	(1.48)	(1.49)	(1.22)	(1.47)	(1.27)	(1.17)
ΔVIX_{t-1}		0.029**		0.032**		0.035**		0.028**
		(2.94)		(3.16)		(3.46)		(2.88)
$LEIGR_t$		-9.406**		-12.464**		-10.692**		-13.566**
		(2.81)		(3.16)		(3.11)		(3.90)
$LEIGR_{t-1}$		12.233*		11.087*		13.204*		11.627*
		(2.53)		(2.43)		(2.46)		(2.47)
$GovShut13_t$		-0.753*		-0.961**		-0.534+		-0.906**
		(2.60)		(3.04)		(1.80)		(2.98)
Adj. R^2	0.437	0.626	0.211	0.470	0.271	0.565	0.392	0.567
S.E.	0.339	0.279	0.376	0.311	0.368	0.287	0.390	0.294
VEC Auto (1)	6.39	10.07	10.40	14.91	11.28	8.82	11.51	11.00
VEC Auto (2)	11.17	7.06	8.52	3.48	9.83	8.92	11.60	8.93
VEC Auto (4)	16.89	11.40	10.58	15.77	15.78	10.34	15.89	6.62

Notes: (i) Absolute t-statistics in parentheses. ** (*) denotes significant at the 99% (95%) confidence level. Regressions use data since 1996q1. (ii) Long-run: Maximum likelihood estimates of the long-run equilibrium relationship $RiskPrem_t = \alpha_0 + \alpha_1 BaaTR_t + \alpha_2 RegCap_t + \mu_t$ using a three equation system with at most one cointegrating vector. (iii) Short-run: OLS estimates of the speed of adjustment and short-run dynamics using the estimated equilibrium correction terms in (ii), $EC_{t-1} = RiskPrem_{t-1} - \alpha_0 - \alpha_1 BaaTR_{t-1} - \alpha_2 RegCap_{t-1}$. (iv) First difference terms of elements in the long-run cointegrating vector after t-1 and some short-run controls omitted to conserve space. (v) Lag lengths chosen to obtain unique significant vectors with sensible coefficients and clean residuals.

Table 4: Estimates of the Risk Premium on Commercial Property Alternative Regulatory Variables

Long-Run Equilibrium in Models 1-4: $\boldsymbol{RiskPrem_t = \alpha_0 + \alpha_1\, BaaTR_{t\text{-}3} + \alpha_2\, RegCapReq + \mu_t}$

Variables	Office		Apartment		Warehouse		Retail Malls	
Model No.	1 *SECBasel*	2 *RegCap*	3 *SECBasel*	4 *RegCap*	5 *SECBasel*	6 *RegCap*	7 *SECBasel*	8 *RegCap*
Const	3.462	1.691	2.929	1.276	3.082	1.443	3.757	1.036
$BaaTR_t$	0.968^{**}	0.950^{**}	0.992^{**}	1.057^{**}	1.024^{**}	1.256^{**}	0.906^{**}	1.210^{**}
	(5.84)	(8.78)	(5.51)	(7.82)	(7.99)	(.7.92)	(4.69)	(8.06)
BaselSEC 1,3,5,7	-1.596^{**}	0.247^{**}	-1.209^{**}	0.208^{**}	-0.925^{**}	0.142^{**}	-1.832^{**}	0.257^{**}
RegCap 2,4,6.8	(6.55)	(10.60)	(4.46)	(6.31)	(5.33)	(4.15)	(6.42)	(7.38)
unique coint.	Yes**	Yes**	Yes**	Yes**	Yes**	Yes**	Yes**	Yes*
vec. # lags	3	5	3	2	5	5	3	4
trace no vec.	40.63^{**}	39.64^{*}	33.68^{*}	31.35^{**}	38.08^{**}	38.78^{**}	34.94^{**}	30.37^{*}
trace only 1	14.22	12.99	14.20	8.63	15.44	8.01	14.42	10.69
Short-Run: $\boldsymbol{\Delta RiskPrem_t = \beta_0 + \beta_1 EC_{t\text{-}1} + \Sigma\beta_{2i}\, \Delta RiskPrem_{t\text{-}i} + \Sigma\beta_{3i}\, \Delta\, BaaTR_{t\text{-}i} + \Sigma\beta_{4i}\, \Delta\, RegCapReq_{t\text{-}i} + \beta_6 X + \varepsilon_t}$								
$EC_{t\text{-}1,}$	-0.336^{**}	-0.601^{**}	-0.270^{**}	-0.279^{**}	-0.435^{**}	-0.337^{**}	-0.242^{**}	-0.356^{**}
'adjust.speed'	(4.43)	(4.35)	(3.24)	(2.97)	(3.67)	(2.98)	(2.81)	(3.35)
$\Delta RiskPrem_{t\text{-}1}$	0.016	0.322^{*}	-0.010	-0.012	0.148	0.076	-0.148	-0.042
	(0.15)	(2.29)	(0.08)	(0.10)	(1.12)	(0.58)	(1.25)	(0.36)
$\Delta BaaTR_{t\text{-}1}$	-0.042	-0.240	-0.127	-0.215	-0.186	-0.126	0.034	-0.107
	(0.25)	(1.30)	(0.71)	(1.27)	(1.09)	(0.71)	(0.17)	(0.57)
$\Delta SECBasel_{t\text{-}1}$ 1,3,5,7	0.286	-0.119^{*}	0.328	-0.067	0.492	-0.069	0.374	-0.053
$\Delta RegCap$ 2,4,6.8	(1.24)	(2.29)	(1.40)	(1.49)	(1.95)	(1.47)	(1.42)	(1.17)
$\Delta VIX_{t\text{-}1}$	0.029^{**}	0.029^{**}	0.033^{**}	0.032^{**}	0.035^{**}	0.035^{**}	0.034^{**}	0.028^{**}
	(2.90)	(2.94)	3.18)	(3.16)	(3.69)	(3.46)	(3.05)	(2.88)
$LEIGR_t$	-11.425^{**}	-9.406^{**}	-10.576^{**}	-12.464^{**}	-8.748^{**}	-10.692^{**}	-12.832^{**}	-13.566^{**}
	(3.43)	(2.81)	(2.98)	(3.16)	(2.72)	(3.11)	(3.22)	(3.90)
$LEIGR_{t\text{-}1}$	11.022^{*}	12.233^{*}	9.794^{*}	11.087^{*}	11.087^{*}	13.204^{*}	8.122	11.627^{*}
	(2.60)	(2.53)	(2.21)	(2.43)	(2.45)	(2.46)	(1.64)	(2.47)
$GovShut13_t$	-1.003^{**}	-0.753^{*}	-1.003^{**}	-0.961^{**}	-0.622^{*}	-0.534^{+}	-0.833^{*}	-0.906^{**}
	(3.26)	(2.60)	(3.41)	(3.04)	(2.26)	(1.80)	(2.34)	(2.98)
Adj. R^2	0.568	0.626	0.476	0.470	0.622	0.565	0.525	0.567
S.E.	0.297	0.279	0.309	0.311	0.368	0.287	0.345	0.294
VEC Auto (1)	8.07	10.07	7.66	14.91	10.25	8.82	28.10^{**}	11.00
VEC Auto (2)	15.68	7.06	5.46	3.48	8.23	8.92	15.23	8.93
VEC Auto (4)	20.79^{*}	11.40	20.89	15.77	8.94	10.34	24.04^{**}	6.62

Notes: (i) Absolute t-statistics in parentheses. **(*) denotes significant at the 99% (95%) confidence level. Regressions use data since 1996q1. (ii) Long-run: Maximum likelihood estimates of the long-run equilibrium relationship $RiskPrem_t = \alpha_0 + \alpha_1 BaaTR_t + \alpha_2 BaselSEC_t + \mu_t$ using a three equation system with at most one cointegrating vector. (iii) Short-run: OLS estimates of the speed of adjustment and short-run dynamics using the estimated equilibrium correction terms in (ii), $EC_{t\text{-}1} = RiskPrem_{t\text{-}1} - \alpha_0 - \alpha_1 BaaTR_{t\text{-}1} - \alpha_2 BaselSEC_{t\text{-}1}$. (iv) First difference terms of elements in the long-run cointegrating vector after t-1 and some short-run controls omitted to conserve space. (v) Lag lengths chosen to obtain unique significant vectors with sensible coefficients and clean residuals.

Appendix Table 1: Estimates of Real Capitalization Rates on Commercial Property (PWC data)

Long-Run Equilibrium: $CapRate_t = \alpha_0 + \alpha_1 ReqRtn_t + \alpha_2 ExpRentGrowth_t + \alpha_3 CapAvail_t + \mu_t$

Variables	Office		Apartment		Retail Malls	
Model No.	1	2	3	4	7	8
Const	1.244	1.922	0.452	2.166	0.373	0.962
$ReqRtn_t$	0.765^{**}	0.776^{**}	0.757^{**}	0.730^{**}	0.724^{*}	0.743^{**}
	(22.23)	(23.39)	(12.17)	(9.77)	(17.98)	(17.28)
ExpRent-	-0.348^{**}	-0.375^{**}	-0.209^{*}	-0.307^{*}	-0.278^{**}	-0.345^{**}
$Growth_t$	(6.18)	(7.17)	(2.01)	(2.26)	(3.26)	(4.04)
$CapAvail_t$	-0.139^{**}	-0.174^{**}	-0.151^{**}	-0.253^{**}	-0.071^{*}	-0.124^{**}
adj.: 2,4,6,8	(4.04)	(4.32)	(3.15)	(3.13)	(2.34)	(3.23)
unique coint.	Yes^{*}	Yes^{*}	Yes^{**}	Yes^{**}	Yes^{*}	Yes^{*}
vec. # lags	2	2	9	9	1	1
trace no vec.	50.41^{*}	48.12^{*}	66.98^{**}	64.62^{**}	50.48^{*}	50.50^{*}
trace only 1	23.82	20.30	28.38	29.08	28.27	24.68
Short-Run: $\Delta CapRate_t = \beta_0 + \beta_1 EC_{t-1} + \Sigma\beta_{2i}\Delta ReqRtn_{t-i} + \Sigma\beta_{3i}\Delta ExpRentGrowth_{t-i} + \Sigma\beta_{4i}\Delta CapAvail_{t-i} + EvRisk_t + \varepsilon_t$						
$EC_{t-1,}$	-0.279^{**}	-0.266^{**}	-0.335	-0.307^{**}	-0.314^{**}	-0.259^{**}
'adjust.speed'	(3.27)	(2.93)	(3.26)	(3.58)	(3.07)	(2.91)
ΔVIX_{t-2}	0.012^{**}	0.012^{**}	0.006	0.008^{*}	0.009^{*}	0.009^{*}
	(3.52)	(3.52)	(1.59)	(2.29)	(2.50)	(2.62)
$\Delta CapRate_{t-1}$	0.684^{**}	0.722^{**}	0.759^{**}	0.696^{**}	-0.010	-0.027
	(3.47)	(3.57)	(3.57)	(3.28)	(0.05)	(0.14)
$\Delta ReqRtn_{t-1}$	-0.476^{*}	-0.477	-0.368^{*}	-0.223	0.234	-0.242
	(2.21)	(2.16)	(2.03)	(1.19)	(1.31)	(0.30)
Δ*ExpRent-*	0.011	-0.012	0.067	0.041	-0.040	-0.038
$Growth_{-1}$	(0.17)	(0.18)	(0.69)	0.48)	(0.69)	(0.65)
$HomeTaxCred_{t-1}$			0.668^{**}	0.454^{*}		
(hurts rentals)			(3.85)	(2.29)		
$NatMortSettlement_t$			0.514^{**}	0.454^{*}		
(hurts rental prop.			(2.81)	(2.29)		
$NatMortSettlement_{t-1}$			-0.410^{*}	-0.563^{*}		
(unwinding effect)			(2.02)	(2.43)		
1998 RussDefault			0.512^{**}	0.534^{*}		
			(3.03)	(3.23)		
Adj. R^2	0.506	0.478	0.841	0.819	0.350	0.341
S.E.	0.157	0.161	0.103	0.109	0.177	0.178
VEC Auto (1)	10.66	7.50	25.11	21.14	23.11	20.66
VEC Auto (2)	11.97	7.64	18.60	19.15	21.41	13.82
VEC Auto (4)	10.92	12.84	13.36	18.93	10.46	11.66

Notes: (i) Absolute t-statistics in parentheses. ** (*) denotes significant at the 99% (95%) confidence level. (ii) Lag lengths chosen to obtain unique significant vectors with sensible coefficients and clean residuals. (iii) First difference terms of elements in the cointegrating vector lagged more than one quarter omitted to conserve space. (iii) Long-run: Maximum likelihood estimates of the long-run equilibrium relationship $CapRate_t = \alpha_0 + \alpha_1 ReqRtn_t + \alpha_2 ExpRentGrowth_t + \alpha_3 CapAvail_t + \mu_t$ using a four equation system with (at most) one cointegrating vector. (iv) Short-run: OLS estimates of the speed of adjustment and short-run dynamics using the estimated equilibrium correction terms in (ii), $EC_{t-1} = CapRate_{t-1} - \alpha_0 - \alpha_1 ReqRtn_{t-1} - \alpha_2 ExpRentGrowth_{t-1} - \alpha_3 CapAvail_{t-1}$.

(v) Adj,.*CapAvail* equals *CapAvail* minus the estimated effects of 2 lags in the change in the *GDPGap*, *BaaTR*, and *RTR* from this regression:

$CapAvail_t = 10.551 - .144\text{x}\Delta GDPGap_{t-1}^{+} - .279*\Delta GDPGap_{t-2}^{**} - 0.988\text{x}BaaTR10_t^{**} - .182\text{x}RTR10_t - .084\text{x}Dum07q3 - 1.133\text{x}Dum98q4$

t-stats. : (10.95) (1.48) (2.88) (5.32) (1.22) (2.42) (3.16) ρ=.929; adj.R^2.933

Appendix Table 2: Estimates of the Risk Premium on Commercial Property (on PWC data)

Long-Run Equilibrium in Models 1-4: $\boldsymbol{RiskPrem_t = \alpha_0 + \alpha_1 BaaTR_{t-3} + \alpha_2 RegCap + \mu_t}$

Variables	Office		Apartment		Retail Malls	
Model No.	1	2 ex.s-run	3	4 ex.s-run	7	8 ex.s-run
Const	2.293	1.460	0.782	0.783	1.184	0.007
$BaaTR_t$	0.728**	1.261**	1.390**	1.471**	2.216**	2.076**
	(5.12)	(7.38)	(7.89)	(8.24)	(7.03)	(7.94)
$RegCap$	0.265**	0.174**	0.225**	0.192**	0.265**	0.118+
	(7.47)	(4.17)	(5.13)	(4.07)	(3.36)	(1.68)
unique coint.	Yes**	Yes**	Yes**	Yes**	Yes**	Yes*
vec. # lags	3	5	4	4	4	4
trace no vec.	40.41**	35.29*	40.66*	44.08**	35.36**	42.38*
trace only 1	14.26	7.57	13.32	13.33	12.33	13.90

Short-Run: $\boldsymbol{\Delta RiskPrem_t = \beta_0 + \beta_1 EC_{t-1} + \Sigma\beta_{2i}\Delta RiskPrem_{t-i} + \Sigma\beta_{3i}\Delta BaaTR_{t-i} + \Sigma\beta_{4i}\Delta RegCapReq_{t-i} + \beta_6 X + \varepsilon_t}$

	1	2 ex.s-run	3	4 ex.s-run	7	8 ex.s-run
$EC_{t-1,}$	-0.398**	-0.221**	-0.273**	-0.282**	-0.117*	-0.184**
'adjust.speed'	(4.85)	(2.81)	(4.30)	(4.92)	(2.51)	(4.04)
$\Delta RiskPrem_{t-1}$	0.231+	0.180	-0.230*	-0.308**	-0.185	-0.329**
	(1.98)	(1.46)	(2.17)	(3.19)	(1.54)	(3.07)
$\Delta BaaTR_{t-1}$	0.041	-0.193	0.128	-0.253	0.061	-0.453*
	(0.32)	(1.08)	(0.99)	(1.50)	(0.40)	(2.31)
$\Delta RegCap_{t-1}$	-0.067	-0.098	-0.037	-0.040	0.020	0.009
	(1.34)	(0.20)	(0.77)	(0.95)	(0.35)	(0.20)
ΔVIX_{t-1}		0.026*		0.022*		0.027**
		(2.52)		(2.44)		(2.55)
$LEIGR_t$		-12.268**		-11.972**		-17.104**
		(3.51)		(3.75)		(4.93)
$LEIGR_{t-1}$		14.857**		11.270*		17.582*
		(2.73)		(2.71)		(3.74)
$GovShut13_t$		-0.674*		-0.670*		-0.420
		(2.18)		(2.21)		(1.21)
Adj. R^2	0.280	0.439	0.315	0.463	0.110	0.371
S.E.	0.342	0.298	0.336	0.297	0.401	0.337
VEC Auto (1)	15.32	8.65	1.36	14.09	3.12	9.74
VEC Auto (2)	7.56	13.43	4.47	9.87	6.22	6.26
VEC Auto (4)	10.35	9.79	7.93	7.65	2.92	5.56

Notes: (i) Absolute t-statistics in parentheses. ** (*) denotes significant at the 99% (95%) confidence level. Regressions use data since 1996q1. (ii) Long-run: Maximum likelihood estimates of the long-run equilibrium relationship $RiskPrem_t = \alpha_0 + \alpha_1 BaaTR_t + \alpha_2 RegCap_t + \mu_t$ using a three equation system with at most one cointegrating vector. (iii) Short-run: OLS estimates of the speed of adjustment and short-run dynamics using the estimated equilibrium correction terms in (ii), $EC_{t-1} = RiskPrem_{t-1} - \alpha_0 - \alpha_1 BaaTR_{t-1} - \alpha_2 RegCap_{t-1}$. Odd numbered models include a dummy for the 2013 federal government shutdown and a dummy for the start (=1 in 1998q3) and unwinding (=-1 in 1998q4) of the Asian Crisis. (iv) First difference terms of elements in the long-run cointegrating vector after t-1 and some short-run controls omitted to conserve space. (v) Lag lengths chosen to obtain unique significant vectors with sensible coefficients and clean residuals.