

**COMMERCIAL REAL ESTATE PRICE VOLATILITY:
CREDIT POLICY VS PROPERTY MARKETS**

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Abstract

The disconnected roles of credit policy versus property market fundamentals in producing volatility for commercial real estate (CRE) prices are investigated. Using data for the U.S. CRE market, income returns and transaction volume are found to have little, if any, impact on capital gains. Instead, capital gains are closely related to immediate past realized values – indicative of return-chasing behavior and reflecting the cyclical nature of CRE assets. Additionally, capital appreciation is strongly impacted by credit policy. In variance decompositions, credit tightening accounts for roughly one-third of the three-year forward prediction error for capital gains, whereas income returns account for just three percent or less. Empirical results obtain under a variety of alternate specifications. Evidence for the influence of credit policy on CRE prices, when effects from property market fundamentals and transactions volume are zero, suggests that CRE lenders effectively control acceptable CRE valuations through underwriting mechanisms. During periods of loose credit, CRE lenders compete with one another on terms and allow valuations to rise. Apart from return-chasing behavior, CRE price volatility is largely caused by cycles in credit policy rather than cycles in the underlying property market fundamentals. The findings of this research study suggest that stabilization in CRE credit policy would likely limit the degree of fluctuation in CRE pricing spirals.

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Introduction

To what extent do fluctuations in credit policy create volatility in commercial real estate (CRE) prices? To evaluate this question, influence from property market conditions must be controlled, including its covariance with CRE lending. The property market component of CRE price volatility is depicted by rents, vacancies, and expenses – or net operating income (NOI) when taken together. Shifts in NOI fundamentals are realized in income returns, or yields. In addition, financial markets place a risk premium on CRE that needs to be identified and changes over time.

CRE is a highly heterogeneous asset class, as is the composition of investors who participate in transactions – having widely-dispersed private valuations for the underlying assets. CRE assets are illiquid, thinly-traded, and transaction costs are high. Values for assets that do not transact remain unobserved, or may be evaluated using valuation ratios such as a multiple of expected NOI – as in the cap rate. Resulting from these conditions, asset prices are inherently volatile. From NCREIF, cap rates in the U.S. on the series of all CRE property types have implied NOI multiples ranging from as low as 9 times NOI to as high as 18.4 during peak valuations of 2007. During the run-up from 2003 to 2007, CRE prices rise 47 percent, only to return to 2003 levels by the end of 2009; rising again 31 percent by mid-2014. CRE prices vary significantly, particularly during the 2003 to 2014 period.

What has failed to fluctuate by the same magnitudes are market values for CRE rents, vacancies, and operating expenses – representing the fundamentals, or operating cash flows from the underlying property market. Instead, the most dramatic adjustments were realized in the capital markets. While financial risk premia adjusted continuously, responding to monetary policy and to indicators from the macro-economy, so too did the policies of CRE lenders. Credit availability seized up following the stock market collapse in 2008 with CMBS issuance virtually disappearing from the CRE finance landscape. Lenders report net tightening in CRE underwriting standards quarter-over-quarter for an extended period. Then, just as abruptly as the lending spigot had been shut off, it turned back on and CRE credit began to flow once again.

This research study considers the role of lenders as gatekeepers to CRE investment. When debt is unavailable or overly restrictive, there are few investors and CRE valuations are disciplined by equity. When debt is superfluous, there is competition among lenders allowing valuations to rise. The analysis for CRE price volatility aims to differentiate among the contributions from credit policy versus property market cycles. If CRE pricing cycles are heavily impacted by “green light-red light” lending spurts, then there are obvious implications for lending policy stabilization with consequences for the long-horizon market efficiency of CRE investment.

I. Background

Consider even the most basic pro forma – or CRE cash flow projection. Comparative statics reveal that a one percent change in effective rent causes a one percentage change in the residual asset value, *ceteris paribus*. It assumes that the cap rate, or NOI divided by

the asset price, is held constant. The cap rate is arguably the most widely applied and discussed valuation metric in CRE industry today. Cap rates have been evaluated for their ability to predict future CRE prices (Ghysels, Plazzi and Valkanov, 2007; Plazzi, Torous and Valkanov, 2010; Ghysels, Plazzi, Torous and Valkanov, 2012). Theoretical foundation behind this notion is that CRE rents and prices should experience a high degree of co-movement – even if the joint path is somewhat unpredictable. Applying the cap rate, if rents rise relative to underlying asset values, then CRE investment will be attracted to the increased yields and prices will be bid up, returning the cap rate to steady state equilibrium. Thus, even though CRE rents and prices may appear to follow a random path when evaluated individually, the cap rate (as their ratio) is a mean-reverting process. High cap rates predict future CRE price increases; low cap rates predict future declines.

Potentially offsetting the discipline of CRE investors are patterns of return-chasing behavior. In the mutual fund literature, investment flows to funds that have recently experienced good performance (Friesen and Sapp, 2007). Momentum trading strategies contribute to periods of sequentially positive returns (Carhart, 1997). As an asset class, CRE is inherently cyclical due to the “persistent mismatch between supply and demand of real estate arising from cyclical demand for space and the lumpy, indivisible, irreversible nature of new supply” (Arsenault, Clayton and Peng, 2013, p.244). CRE prices exhibit highly cyclical patterns making the asset class relatively attractive to return-chasing investors.

In Jorgenson's (1960) theory of investment, the user cost equals interest rates, i , minus capital gains, g . In CRE, the user cost is the cap rate, defined as NOI, U , divided by the asset price, P .

$$\frac{U}{P} = i - g. \quad (1)$$

Rearranging terms and taking the natural log on both sides results in

$$\ln(P) = \ln(U) + \ln(g - i). \quad (2)$$

If true, the only impacts on CRE prices are those responding to shifts in the underlying property market, or changes in the financial risk premia. As an alternative, this study considers that CRE price volatility, σ_P^2 , may be influenced, not only by volatilities in the underlying property market, U , and in the financial risk premia, π , but also by volatility in CRE credit policy, K .

$$\sigma_P^2 = \beta_U \sigma_U^2 + \beta_\pi \sigma_\pi^2 + \beta_K \sigma_K^2 - \beta_{U\pi} \text{cov}(U, \pi) - \beta_{\pi K} \text{cov}(\pi, K) - \beta_{UK} \text{cov}(U, K). \quad (3)$$

The null hypothesis is that underlying property fundamentals and financial risk premia account for all CRE price volatility, then the consequence from credit availability is zero ($\beta_K = 0$). If, instead, excess credit enables increased investment beyond levels supported by property fundamentals or the financial risk premia, then the null hypothesis will be rejected. Alternatively, during periods of credit scarcity, underinvestment may occur with asset prices driven below values that would be justified by risk-adjusted cash flows. The specific empirical goal is to quantify the relative change in CRE prices resulting from credit policy.

A related issue (to the lending channel) involves the impact of liquidity in CRE markets. Relaxed underwriting constraints potentially impact CRE transaction markets in at least three ways: (i) by increasing liquidity, (ii) by enabling unsophisticated market

entrants, and (iii) by revising levered valuations. An overall increase in the supply of CRE loanable funds can create an increase in market liquidity, reducing the liquidity premium, resulting in higher valuations. Ling, Marcato and McAllister (2009) argue that increased transactions volume enhances price revelation, reducing investment risk associated with noisy asset values. Rising asset prices add favor to the CRE outlook, attracting increased investment in a liquidity feedback loop. Clayton (2009) discusses the liquidity feedback loop wherein credit availability enables investment demand for CRE assets, producing increased transactions and liquidity, which puts upward pressure on CRE values, which causes CRE lending to look increasingly attractive, and so on. Effects on CRE prices responding to the liquidity impact should be related to empirical measures for CRE transaction volume.

Liquidity alone is known to correspond with periods of rising asset prices and has been studied extensively in the finance literature. Considering cross-sectional empirical evidence, required returns are higher and asset prices lower for less liquid assets or assets with high liquidity risk (Amihud, Mendelson and Pedersen, 2005). On a time-series basis, the evidence is less conclusive. Stock prices and liquidity exhibit a strong positive contemporaneous relation, but the case for causality is mixed. Increases in trading volume tend to follow periods of higher returns, yet there is only limited evidence that future higher returns are Granger caused by increases in trading volume (Karpoff, 1987; Chen, Firth and Rui, 2001; Lee and Rui, 2002; Chuang, Kuan and Lin, 2009). On the other hand, Kaniel, Ozoguz and Starks (2012) and Gervais, Kaniel and Mingelgrin (2001) provide evidence for a very specific connection between liquidity and asset prices: the high volume return premium.

In CRE markets, new entrants to the transaction market potentially arrive as a consequence of less restrictive credit standards – increasing liquidity, such as marginal borrowers who may have previously been capital-constrained and unable to purchase bulky CRE assets. New entrants to any market typically have a lower degree of sophistication, such as uninformed buyers with unrealistic valuations or “irrationally over-optimistic traders” (Clayton, MacKinnon and Peng, 2005). In the game that potentially ends with winner’s curse, buyers with uninformed values walk away from the bidding war victorious. To the extent that a reduction in credit tightening coincides with the arrival of unsophisticated buyers, CRE prices will be bid up due to increases in information asymmetry. New buyers may enter the CRE market when underwriting standards are relaxed, such as occurs when CRE loans are underwritten with higher loan-to-value (LTV) ratios or lower debt service coverage ratios (DSCR).

Beyond effects for liquidity and uninformed investors, credit availability also has the potential to adjust valuations for a representative investor in the market – due to the high degree of financial leveraged used in the typical CRE purchase. Consider an asset that yields NOI of \$1, annual NOI growth equals 1 percent, the exit cap rate on a five-year hold is 5 percent, and the cost of debt for a five-year interest-only loan is 3 percent (i.e., positive leverage).¹ For an investor seeking 10 percent leveraged returns, the difference between banks willing to lend \$10 versus \$14 toward the purchase impacts their valuation by 5.42 percent.² This illustrates the valuation effect of credit availability.

While underwriting standards include both LTV and DSCR, LTV ratios are more likely

¹ Property cash flows before debt service are \$1, \$1.01, \$1.02, \$1.03, and \$22.06 in years 1 thru 5.

² For the \$10 loan, before-tax cash flows are \$0.70, \$0.71, \$0.72, \$0.73, and \$11.76. The value of the equity position at 10 percent is \$9.57. The asset value is \$9.57 plus \$10 in debt. For the \$14 loan, before-tax cash flows are \$0.58, \$0.59, \$0.60, \$0.61, and \$7.64. The asset is worth \$20.63 to the investor, an increase of 5.42 percent.

to be the binding criteria in a low interest rate environment. The challenge with quantifying the valuation effect is that LTV and DSCR standards are difficult to observe directly.

Wilcox (2012) develops an index for CRE mortgage underwriting. Wilcox argues that LTV ratios alone are unlikely to accurately reflect underwriting standards due to unobserved mezzanine debt in CRE, issues with accurately estimating CRE values, and that LTV is but one of many terms negotiated by borrowers in the typical CRE deal. The last comment echoes the notion that LTV ratios are potentially endogenous with a host of other underwriting criteria, as suggested by Grovenstein, Harding, Sirmans, Thebpanya and Turnbull (2007). Wilcox finds that underwriting loosened in response to CRE asset price appreciation, exacerbating the CRE price cycle, confirming the feedback loop outlined by Clayton (2009).

While underwriting quality may be very difficult to measure directly, and potential increases in transaction volume may have confounding effects, it is possible to evaluate the impact of reported bank tightening while controlling for liquidity effects. In the work most closely related to the present study, Ling, Naranjo and Scheick (2014) provide such a test. The authors run a VAR model, evaluating liquidity, returns, credit tightening, and investor sentiment for public and private CRE markets.

A key distinction from the Ling, Naranjo and Scheick (2014) study is that, in the current study, the focus is on CRE prices (i.e., capital gains) rather than total returns. Under this approach, the empirical goal is to differentiate the components of CRE price movements that respond to changes in the property market fundamentals versus shifts in the CRE credit policy. Consistent with the Ling, Naranjo and Scheick (2014) study, the

FRB Senior Loan Officers Survey is used as the central measure for credit tightening, and liquidity is controlled using the turnover in the NCREIF index as a proxy for volume, following Fisher, Gatzlaff, Geltner and Haurin (2003). Unlike the Ling, Naranjo and Scheick (2014) study, the NCREIF measure for capital gains is used instead of the Transactions-Based Index (TBI) measure for two reasons. First, the TBI measure is a noisy measure, making it exceedingly difficult to identify a common trend. Second, the present study is focused on a deconstructed cap rate, evaluative of the discussion in Ghysels, Plazzi, Torous and Valkanov (2012) that NOI and prices are cointegrated. The NCREIF capital gains measure is indeed non-stationary (while the TBI measure is stationary) enabling tests for cointegration between income returns and capital gains, along with the potential for error correction modeling. This study provides a four variable VAR model for comparison to the results of the Ling, Naranjo and Scheick (2014) study. A number of additional underwriting standards that have been proposed in the literature are evaluated. An indirect underwriting measure is constructed from the principal components of the most informative measures. Alternative specifications are provided wherein only endogenous measures are considered revealing that the set of exogenous measures offers little model improvement. The all-endogenous models are then used to generate variance decompositions which illustrate the portion of the prediction error that is explained by credit policy versus property markets.

An empirical issue with the NCREIF capital gains measure is that it is appraisal-based. Appraisal-based indices reflect changes in underlying asset values with a lag and are generally smoother than transaction-based indices. An alternative is to use the TBI, developed in Geltner and Pollakowski (2007). The TBI combines a hedonic model for

actual transaction prices with lagged appraisal values to estimate values for unsold properties. The TBI is used to forecast CRE prices by Plazzi, Torous and Valkanov (2011) and MacKinnon and Al-Zaman (2009). The appeal of the TBI is that the series is generally stationary (i.e., not serially correlated over short horizons), leaving the forecasting models relatively uncomplicated. One downside of the TBI is that it is truly asking a lot of the data: CRE transactions are highly heterogeneous and there are few transactions per quarter (within each market, for each property type). Thus, the hedonic estimation and predicted values are inherently noisy. As a result, the TBI capital gains returns series provides a noisy representation of the NCREIF capital gains series. The two series are highly correlated and appear to move together in all sub-periods. The TBI series does not appear to significantly lead the NCREIF return series at the quarterly frequency. Perhaps with monthly data, appraisal-smoothing may cause greater concern, yet during the lapse of a calendar quarter it is possible that enough information is revealed for an appraisal-based index to reflect aggregate changes.

This study focuses on the relationship between income returns, capital gains, and CRE credit tightening at the aggregate level (because CRE tightening is an aggregate measure). An evaluative statement is whether effective rents and CRE prices are cointegrated. If true, the two series share a common stochastic trend. The qualifying statement in the definition of cointegration is that both series are nonstationary, yet the TBI series is stationary. In Ghysels, Plazzi, Torous and Valkanov (2012), the NCREIF series is more predictable than TBI series (R-square in Table 5 approach 76.7 percent for NCREIF vs. 31.7 percent for TBI). In this study, the NCREIF series is used because (i) the inability of appraisal-smoothing to reflect immediate changes in transaction values is

potentially trivial with quarterly data, (ii) the TBI series is highly noisy rendering it less useful for return predictability, and (iii) the stationary property of the TBI series makes evaluation of the cointegration relationship between rents and prices impractical. Using NCREIF instead of TBI actually biases the analysis in favor of finding causality for income returns to capital gains.

III. Data & Methodology

CRE return data for the U.S. are collected from NCREIF and evaluated for all property types. Properties in the NCREIF data are institutional-grade CRE assets managed by real estate investment fiduciaries for tax-exempt investors. The NCREIF National Property Index (NPI) is a value-weighted index based on appraised property values. The NCREIF NPI returns series is available at quarterly frequency from 1978Q1 thru 2014Q2, and partitioned into Income Returns and Capital Gains components. Figure 1 displays the time series. Income Returns are depicted by the dashed line; Capital Gains by the solid bold line. Volume is measured as the percentage of turnover in the NCREIF database per quarter based on the number of transactions in the TBI (Transactions-Based Index) which initiates in 1982. The proxy for Volume using turnover in the NCREIF index was developed by Fisher, Gatzlaff, Geltner and Haurin (2003) – it is the same measure as used by Ling, Naranjo and Scheick (2014).

From Figure 1 it is apparent that Capital Gains returns are highly volatile while Income Returns are stable through CRE cycles. Table 1 presents summary statistics for the 96 quarter sample period. Values for the NCREIF series include Income Returns, Capital Gains, and Volume. Quarterly Income Returns average 1.8 percent with standard deviation 0.3 percent. By comparison, the sample average for Capital Gains is 0.1 percent

with standard deviation 2.4 percent. Capital Gains are much more volatile than Income Returns throughout the sample. The standard deviation of quarterly Capital Gains is 8 times greater than that of Income Returns, even while average Capital Gains are less than 1/18th the average value for Income Returns. Capital Gains and Income Returns series are largely uncorrelated spanning multiple economic cycles (correlation coefficients is just 0.017 for the series). Anecdotally, the picture in Figure 1 suggests that cycles in CRE prices are unlikely determined exclusively by cycles in the underlying property market fundamentals. Thus, the role of capital market conditions in producing asset price cyclicity for CRE is given careful consideration.

Capital markets include both debt and equity. The contribution of credit policy is the central focus of this study. The variable of interest is CRE Tightening from the Federal Reserve Board's Senior Loan Officer Opinion Survey on Bank Lending Practices. CRE Tightening measures the net percentage of domestic banks reporting net tightening on standards for CRE loans. The CRE Tightening measure is reported at quarterly frequency from 1990Q3 thru 2014Q2, which represents the sample period for the analysis in this study [96 quarters]. Overall, banks are net tightening during the sample. The average share of banks net tightening their lending standards in the CRE sector is 13.7 percent. Yet, CRE lending policy is quite volatile and unsmooth with standard deviation 25.9 percent; values range from 23.7 percent of banks net loosening to 87 percent net tightening during the sample. Figure 2 shows the pattern in Credit Tightening and inverted Capital Gains for the sample period. The two series move in unison with CRE Tightening in the lead. Spikes in CRE Tightening are commonly followed soon after by sharp declines in Capital Gains.

Wilcox (2012) comments that net tightening may not fully capture CRE underwriting standards and develops his own underwriting index as an alternative measure. In an attempt to address this concern, several other CRE mortgage condition measures are considered including Relative Tightening, CRE Mtg Flows, CRE Debt, and CRE Spread. Relative Tightening measures the difference between net tightening on commercial/industrial loans to large/middle-market firms and net tightening in CRE lending standards. Relative Tightening attempts to isolate the component of changes in bank lending policy that is CRE sector-specific. Lending policy is increasingly restrictive relative to commercial loans during the sample, with average Relative Tightening at 7.7 percent for CRE lending over commercial loans.

Another possible issue with the CRE Tightening measure is that it is based on survey responses and does not directly measure a quantity of loans approved in the CRE market. CRE Mtg Flows provides such a measure, based on Flow of Funds data from the Federal Reserve. CRE Mtg Flows measures the percentage change in CRE mortgage originations from the prior quarter. Average CRE Mtg Flows are increasing 1.1 percent per quarter, but rise by as much as 6 percent at the peak. Another direct measure for CRE lending is total CRE Debt, which accounts for the total outstanding balance of CRE mortgage debt – scaled by GDP. CRE Debt ranges from 9 percent to 18 percent of GDP during the sample.

Mortgage pricing, or yields, are also relevant to asset prices (in addition to mortgage quantities). CRE Spread measures the difference between NCREIF cap rates and yields on 10-year Treasuries. The CRE Spread measure is included in the Cleveland Financial Stress Index. During the sample period, the risk-free interest rate (R_F) is very

low and experiences little volatility, while yields on Baa-rated bonds are more closely related to CRE cap rates. The pattern is shown in Figure 3, along with CRE debt levels. Accordingly, the Baa rate is used as the baseline yield in place of the risk-free rate in estimations where exogenous factors are included. Otherwise, the set of exogenous factors is largely consistent with that of Ling, Naranjo and Scheick (2014), including the Fama-French three factors, collected from Professor French's website: the market risk premium ($R_M - R_F$), high-minus-low (HML), and small-minus-big (SMB); the credit spread (Baa - Aaa), and the term structure (10yr - 1yr) from the Federal Reserve's Selected Interest Rates series. Apart from presentation of summary statistics in Table 1, all variables are standardized with zero mean and unit standard deviation to limit issues with comparing effects after modeling for variables that have different ranges or units of measure.

The empirical approach considers that Income Returns, Capital Gains, Volume (transactions), and Credit Tightening are mutually endogenous CRE variables. To determine the appropriate methodology, the four variables are evaluated for issues that are prevalent in time series data. Results from the time series due diligence tests are reported in Table 2. In Panel A, all four series are non-stationary. In Panel B, three subsets of endogenous variables are tested for cointegration. The set {Income Returns, Capital Gains, CRE Tightening, Volume} has two cointegrating vectors. The sets {Income Returns, Capital Gains, CRE Tightening} and {Income Returns, Capital Gains} each have a single cointegrating vector – suggesting that an error correction model may be appropriate. In Panel C, all four variables are rejected for weak exogeneity when tested against the various subsets of remaining variables. In Panel D, it can be rejected

that each of the four endogenous variables causes, while not being caused by, subsets of the remaining variables with one exception: Income Returns do not cause Capital Gains when considered in isolation.

In light of the time series due diligence, the empirical analysis considers three models – with varying econometric tradeoffs involved. Each model considers variables lagged one period, due to the quarterly nature of the data and to provide consistency in model comparison. Two versions of each model are estimated: one includes endogenous variables only; the second includes a set of six exogenous controls. The exogenous controls are the Baa rate, $(R_M - R_F)$, HML, SMB, $(Baa - Aaa)$, and $(10yr - 1yr)$.

The first model is the vector error correction model (VECM), evaluating Income Returns, Capital Gains, and CRE Tightening as endogenous. When two or more variables are non-stationary they may be cointegrated and share a common stochastic trend. The two-stage VECM may be appropriate when there is only one cointegrating vector (as evidenced for the set of variables in time series due diligence), leading to a single error correction term. The VECM has the advantage of embedding short-run dynamics and long-run equilibrium in two stages.

When there is evidence of more than one cointegrating vector, vector autoregressive (VAR) modeling can be applied to capture the dynamic linkages among the set of variables. VAR modeling does not require the same set of restrictions on underlying parameters as VECM. Ordering of endogenous variables in the VAR system of equations may affect the empirical outcome. In this study, the effects in a given quarter are assumed to hold the following sequential order: Income Returns, Credit Tightening, Volume, Capital Gains. Income Returns from the property market are observed first.

Credit Tightening can then be adjusted based on information about the property market fundamentals. Quarterly transaction Volume is affected by the degree of Credit Tightening. Finally, Capital Gains are realized as a consequence of all of the above, including shifts in Income Returns making asset yields more or less attractive, Credit Tightening impacting levered returns and Volume, then Volume directly affecting Capital Gains due to the highly illiquid nature of CRE transactions markets. Ultimately, the empirical results using the series of data in this study are robust to alternative ordering selections.

This study presents two sets of results for each VECM and VAR model. The first set of results includes all endogenous variables, along with six exogenous variables that are used to condition the endogenous measures for other potential sources of variation responding to macroeconomic conditions. The first set of results is provided for comparison to related work in the extant literature. The second set of results includes only endogenous variables (i.e., does not include exogenous factors). The advantage of the second approach is in the opportunity to quantify the variance decomposition when only endogenous variables are included. To produce the impulse response functions (IRF) and variance decompositions, the Choleski decomposition is used, which models the error term matrix as a recursive triangular system. The number of lags is selected based on AIC criteria. AIC values are highly similar in models with one, two or three lags. However, none of the endogenous or exogenous variables appear significant beyond the first lag, thus VAR/VECM(1,1) and VAR/VECM(1) models are reported in this study, while higher lag options produce qualitatively similar results.

IV. Results

Results from the VECM estimations are presented in Table 3. In the first-stage, the long-run equilibrium relation between Capital Gains, Income Returns, and CRE Tightening is estimated. The coefficients are 0.666 for Capital Gains and -0.269 for CRE Tightening, whereas Income Returns has no significant effect on Capital Gains in the long-run. Capital Gains are highly sensitive to CRE Tightening. When deviations in Capital Gains from its mean coincide with deviations in CRE Tightening that are 2.5 times greater, there is no need for error correction and the two variables are in long-run equilibrium. Thus, there is an optimal responsiveness of credit policy to CRE price growth.

The error term from the first-stage of the VECM is collected and included in the second-stage for first-differences – considering short-run dynamics. Increases in CRE Tightening create distortions in CRE asset prices causing Capital Gains to be too high relative to long-run equilibrium. From the Error Correction coefficient, no less than 100 percent of any such deviation in Capital Gains from long-run equilibrium will be corrected in the subsequent quarter. A one standard deviation increase in CRE Tightening (26 percent of banks net tightening to CRE sector) immediately causes a 0.21 standard deviation reduction in Capital Gains (50 basis points, which is 5 times greater than the mean value) in the following quarter. Income Returns have zero impact on Capital Gains in both the short-run and long-run. Surprisingly, upon introducing the Error Correction term, lagged changes in Capital Gains have no immediate effect on current realized values. Neither do any of the exogenous factors considered. In the immediate horizon, the only distortions in Capital Gains are in response to CRE Tightening along with an Error Correction term that quickly returns the two series to their long-run equilibrium state.

Results from the estimation of the VAR system that includes four equations (VAR:4) with four endogenous variables and six exogenous variables are presented in Table 4. Income Returns are positively related to prior values, but inversely related to Capital Gains. Following periods of capital appreciation, asset prices are bid upward relative to income, lowering yields. CRE Tightening replicates its own past behavior and is also inversely related to macroeconomic factors including the market risk premium and SMB. When yields on risky assets rise relative to the risk-free rate, credit is loosened in the following period. Transactions Volume is positively related to Income Returns, Capital Gains, and recent Volume, but responds negatively to CRE Tightening – consistent with expectations.

In the far-right columns of Table 4, evidence for the long-run equilibrium relationship between Capital Gains and CRE Tightening is largely consistent with results from the VECM estimations. Capital Gains are positively related to their past realized value. Positive Capital Gains create higher valuations that are followed by subsequently higher valuations. Periods of asset sell-offs and dropping values are also sequential. An increase in CRE Tightening clamps down on the Capital Gains trajectory.

Table 5 presents results for the specification that includes only three endogenous factors (VAR:3): Income Returns, Capital Gains, and a CRE Lending Index constructed from the principal components of four underwriting measures. The four underwriting measures are Relative Tightening, CRE Tightening, Volume, and the percentage change in CRE Mtg Flows. These four measures are identified as the most informative underwriting measures, based on factor analysis for a set of measures that also included CRE Debt and CRE Spread. Applying the CRE Lending Index produces highly similar

results to the CRE Tightening measure. In the Capital Gains estimation, coefficients for lagged Capital Gains are 0.689 and 0.684 (compared with coefficients of 0.623 and 0.680 in Table 4), while the coefficient for the CRE Lending Index is -0.192 (compared to values of -0.268 and -0.273 for CRE Tightening in Table 4). Once again, suppressing exogenous factors in the estimation produces similar results. Periods of high income returns are preceded by periods of high income returns. It suggests that changes in the underlying property market fundamentals are sustained over a long horizon, such as improvements in the sector occupancy rates or effective rents.

Figure 4 illustrates the response function for Capital Gains following the orthogonalized impulses of Income Returns (in Panel A), CRE Tightening (in Panel B), and Capital Gains (in Panel C). A one standard deviation shock to Income Returns has essentially zero impact on Capital Gains – even up to three years after. In all three models, a one standard deviation shock to CRE Tightening (Panel B) has a negative and significant impact on Capital Gains, pulling down asset prices by -0.1 to -0.2 standard deviations (24 to 48 basis points per quarter) over an extended horizon. In Panel C, increases in Capital Gains in a given period are positively related to the prior period increase. Apart from its own past realized value, Capital Gains are not determined by yields in the underlying property market (i.e., Income Returns). Instead, changes in CRE Tightening plays the central role in affecting Capital Gains outcomes – with lasting effects.

The fully endogenous VAR and VECM specifications enable variance decompositions. Table 6 reports the 4, 8, and 12 quarter lead prediction errors that are explained by each endogenous measure. Volatility in Income Returns is explained largely

by its own variance and also by volatility in Capital Gains. Over a one- to three-year horizon, 28 to 54 percent of the variance in Income Returns is explained by fluctuations in Capital Gains. By comparison, volatility in CRE Tightening is predominantly explained by its own preceding realized value. No less than 77 percent of the prediction error for CRE Tightening is explained by past volatility in CRE Tightening. This result suggests that CRE Tightening is largely decided at a macroeconomic and policy level, rather than as responsive to changes in the asset market itself. For Capital Gains, volatility in CRE Tightening has long-lasting effects. Up to 37 percent of the variance in Capital Gains is explained by changes in credit policy over a subsequent 12 quarter period.

V. Conclusions

Conventional wisdom suggests that asset prices should respond to income yields and should exhibit some sensitivity to transaction volume in a highly illiquid market, such as CRE. Evidence provided in this study fails to support either of these assertions. Capital gains in CRE are largely unresponsive to changes in income returns and transaction volume. Instead, the illiquid nature of the asset market perpetuates periods of autocorrelation in capital gains, creating an inefficient market characterized by slow and prolonged pricing cycles. Apart from return-chasing behavior, the dominant factor affecting CRE pricing cycles is credit policy, accounting for up to 37 percent of the prediction error in capital gains. Credit tightening itself is largely unrelated to CRE fundamentals.

Looseness or tightness in credit policy can be transmitted to CRE asset prices in a number of ways. However, considering evidence that CRE price volatility is affected by credit policy and not transaction volume suggests that these price effects are not caused by the liquidity channel. Instead, shifts in credit policy directly affect levered returns for assets sold in a given period, enabling investors to lever up or lever down their valuations on assets available for purchase. Thus, credit policy transmission to CRE prices occurs through the valuation channel rather than the liquidity channel as previously believed. The results of this study suggest that a more stabilized and consistent credit policy is likely to significantly reduce the magnitude of fluctuations in CRE pricing spirals.

Appendix. Alternate Specifications & Data

For robustness, a few alternative specifications are considered. One concern is that the Income Returns measure does not directly measure yields, or at least in the way that CRE investors are applying yields for investment purpose. Alternate I considers using Cap Rates as a substitute for Income Returns, which offers a linkage to property market effects that is more aligned with the framework of Ghysels, Plazzi, Torous and Valkanov (2012). Cap Rates are collected from NCREIF for all property types and all regions. A second concern is that investors may be primarily concerned with forward-looking expected values for income returns (rather than past values). Alternate II provides a specification where the lagged Income Returns measure is replaced by its four quarter forward expected value, generated from an autoregressive process. A third concern is that the CRE Lending Index measure is dominated by the CRE Tightening measure, so it may be revealing to see an alternative lending index. In Alternate III, Volume is replaced by CRE Lending Index' – constructed from the principal components of the four following underwriting measures: CRE Debt, Volume, CRE Mtg Flows, and CRE Spread. Interestingly, CRE Lending Index' is largely uncorrelated with CRE Tightening. Results for Alternate specifications I, II, and III are provided in Table A1. The central result is largely unchanged under the alternate specifications. Capital Gains respond positively to recent changes in Capital Gains and negative to recent changes in CRE Tightening. Credit policy accounts for a large portion of the forecast error for Capital Gains, while influence from the property market is close to zero.

An alternate to the NCREIF series is Real Capital Analytics (RCA), available at monthly frequency beginning in December 2000. RCA data has 160 monthly

observations compared to 96 quarterly observations for NCREIF, although the series spans fewer cycles. An issue with Income Returns is that asset values are implicitly in the denominator, even if unobserved for several periods, leading to potentially abrupt changes when asset valuations are adjusted. Income reporting may be smoothed over calendar quarters for accounting purposes. Thus, Income Returns do not provide as direct a measure for property market fundamentals as NOI on per square foot basis might, which is available in the RCA data. Another concern is whether NCREIF turnover is the most meaningful proxy for aggregate transaction volume since assets comprising the TBI represent a relatively small percentage of total CRE assets and they are held by tax-exempt institutional investor clienteles (primarily pension funds). A direct measure for transaction volume based on the total dollar amount of CRE sold is available in the RCA data. Finally, the Moody's/RCA Commercial Property Price Index (CPPI) is a constant-quality index and is not appraisal based, which circumvents issues with TBI and NCREIF NPI measures for Capital Gains. Results from estimations by property type using the RCA data are presented in Table A2. The central findings of this study are robust to the alternate data source.

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Table 1. Summary statistics: 1990Q3–2014Q2

Variable	Mean	Std dev	Min	Median	Max
Income Returns	1.8%	0.3%	1.2%	1.8%	2.2%
Capital Gains	0.1%	2.4%	-9.7%	0.5%	3.9%
Volume	2.1%	1.2%	0.3%	1.9%	5.7%
CRE Tightening	13.7%	25.9%	-23.7%	5.2%	87.0%
Relative Tightening	7.7%	11.2%	-17.5%	6.1%	48.1%
CRE Mtg Flows	1.1%	1.8%	-2.3%	1.3%	6.0%
CRE Debt	12.7%	2.5%	9.2%	12.7%	17.9%
CRE Spread	3.0%	1.2%	-0.1%	3.1%	5.0%
R_F	0.2%	0.2%	0.0%	0.3%	0.6%
$(R_M - R_F)$	0.6%	2.8%	-7.8%	1.0%	6.5%
HML	0.3%	2.1%	-6.8%	0.2%	7.8%
SMB	0.2%	1.7%	-3.6%	0.3%	4.1%
Baa	7.3%	1.4%	4.6%	7.4%	10.6%
$(Baa - Aaa)$	1.0%	0.4%	0.6%	0.9%	3.0%
$(10yr - 1yr)$	1.6%	1.1%	-0.4%	1.7%	3.4%

Notes: This table presents summary statistics for the time series of data during the period 1990Q3 to 2014Q2, including the sample Mean, standard deviation (Std dev), minimum (Min), Median, and maximum (Max) values. Income Returns and Capital Gains are from NCREIF's NPI return series for all property types and all regions, partitioned into income returns (ireturn) and capital appreciation (areturn). Volume measures the percentage turnover in the NCREIF database per quarter based on transactions count for the TBI. CRE Tightening measures the net percentage of domestic banks reporting net tightening on standards for CRE loans, collected from the Federal Reserve Board's Senior Loan Officer Opinion Survey on Bank Lending Practices. Relative Tightening measures the difference between net tightening on commercial/industrial loans to large/middle-market firms and net tightening on CRE lending standards. CRE Mtg Flows measures the percentage change in CRE mortgage originations from the prior quarter, based on Flow of Funds data from the Federal Reserve. CRE Debt measures the total outstanding balance of CRE mortgage debt, scaled by national GDP. CRE Spread measures the difference between NCREIF cap rates and yields on 10-year Treasuries. R_F is the one-month Treasury bill rate. $(R_M - R_F)$ is the excess return on the market. HML (high minus low) is the average return on value portfolios minus the average return on growth portfolios. SMB (small minus big) is the average return on small portfolios minus the average return on big portfolios. $(R_M - R_F)$, R_F , HML, and SMB are collected from the data library website of Professor Kenneth French. Baa is the Moody's yield on Baa-rated seasoned corporate bonds. $(Baa - Aaa)$ is the credit spread, calculated as the Moody's yield on Baa-rated seasoned corporate bonds minus the Moody's yield on Aaa-rated seasoned corporate bonds. $(10yr - 1yr)$ represents the yield curve, calculated as the market yield on 10-year U.S. Treasury securities minus the market yield on 1-year Treasuries. Baa, Aaa, 10yr, and 1yr rates are from the Board of Governors of the Federal Reserve System, Selected Interest Rates–H.15 series. All variables are reported at quarterly frequency, totaling 96 observations.

Table 2. Time-series due diligence

Panel A. Summary of unit root tests			
Income Returns, y	Capital Gains, c	CRE Tightening, z	Volume, v
I(1)	I(1)	I(1)	I(1)
Panel B. Cointegration tests			
Set:	$\{y, c, z, v\}$	$\{y, c, z\}$	$\{y, c\}$
Rank	Trace	Trace	Trace
0	113.5**	71.1**	44.3**
1	55.4**	14.5	1.6
2	14.7	1.2	
3	1.3		
Panel C. Weak exogeneity tests			
Set:	$\{y, c, z, v\}$	$\{y, c, z\}$	$\{y, c\}$
Income Returns, y	31.7***	31.8***	33.6***
Capital Gains, c	15.9***	15.0***	9.5***
CRE Tightening, z	9.3***	8.3***	
Volume, v	26.1***		
Panel D. Granger causality tests			
Set:	$\{y, c, z, v\}$	$\{y, c, z\}$	$\{y, c\}$
Income Returns, y	43.2***	42.5***	41.0***
Capital Gains, c	18.4***	17.0***	1.6
CRE Tightening, z	7.8**	6.9**	
Volume, v	15.4***		

Notes: This table summarizes the results of the time series due diligence tests conducted on the series for Income Returns (y), Capital Gains (c), CRE Tightening (z), and Volume (v). All variables are described in the notes to Table 1. Panel A provides the conclusion based on the Augmented Dickey–Fuller (1981) unit root tests, considering zero mean, constant term, and time trend versions at (-1,-4) lags for each measure. I(1) indicates that the variable is stationary after first-differencing. Panel B provides the results of the Johansen (1988) cointegration rank test based on trace statistics. ** in Panel B indicates that, for the set of variables included in the test, the presence of rank n or fewer cointegrating vectors can be rejected at the 5% level of significance. Panel C provides results on the weak exogeneity test. *** in Panel C indicates that the weak exogeneity assumption of each row variable relative to the remaining variables in the column set can be rejected at the 1% level of significance. Panel D provides results of the Granger causality tests. *** and ** indicate that the assumption that the row variable does cause the remaining column variables in the set, but the remaining column variables in the set do not cause the row variable can be rejected at the 1% and 5% level of significance.

Table 3. Vector error correction model (VECM)

Variable	Coefficient	(t-stat)	Coefficient	(t-stat)
(a) Dependent variable: Capital Gains _t				
Capital Gains _{t-1}	0.666 ***	(10.0)	0.666 ***	(10.0)
Income Returns _{t-1}	0.020	(0.3)	0.020	(0.3)
CRE Tightening _{t-1}	-0.269 ***	(-3.9)	-0.269 ***	(-3.9)
(b) Dependent variable: ΔCapital Gains _t				
ΔCapital Gains _{t-1}	0.296	(1.5)	0.190	(0.8)
Error Correction _t	-1.209 ***	(-3.3)	-1.117 ***	(-2.9)
ΔIncome Returns _{t-1}	0.113	(1.1)	0.120	(1.1)
ΔCRE Tightening _{t-1}	-0.210 **	(-2.3)	-0.181 *	(-1.8)
ΔBaa _{t-1}			-0.084	(-0.7)
Δ(R _M - R _F) _{t-1}			0.071	(0.6)
ΔHML _{t-1}			-0.054	(-0.8)
ΔSMB _{t-1}			-0.057	(0.4)
Δ(Baa - Aaa) _{t-1}			-0.109	(-0.5)
Δ(10yr - 1yr) _{t-1}			0.044	(-0.5)
Adjusted R ² :	23.4%		20.9%	
Observations:	94		94	

Notes: This table presents results from two versions of the vector error correction model (VECM). In the first specification, only endogenous variables are included. In the second set of results (displayed in far-right columns), a set of exogenous controls is added for Baa rates, the Fama-French factors, the credit spread, and the yield curve. Results for the estimated long-run cointegrating relationship are presented in the top rows, under (a), followed by the short-run dynamic relationship including the Error Correction term, under (b). First-differenced variables are denoted by Δ. The table displays the parameter estimates (Coefficient), along with the corresponding t-statistic in parentheses. All variables are defined in the notes to Table 1. ***, **, and * indicate statistically significant coefficients at the 1%, 5%, and 10% levels respectively.

Table 4. Vector autoregressive model: Four endogenous variables (VAR:4)

Panel A. Four endogenous only								
<i>Dependent:</i>	<i>Income Returns_t</i>		<i>CRE Tightening_t</i>		<i>Volume_t</i>		<i>Capital Gains_t</i>	
Variable	Coef	(t-stat)	Coef	(t-stat)	Coef	(t-stat)	Coef	(t-stat)
Income Returns _{t-1}	0.994 ^{***}	(60.2)	0.003	(0.1)	0.161 [*]	(1.9)	0.001	(0.0)
Capital Gains _{t-1}	-0.100 ^{***}	(-4.8)	0.144 ^{***}	(2.7)	0.247 ^{**}	(2.3)	0.623 ^{***}	(8.1)
Volume _{t-1}	-0.017	(-0.9)	-0.048	(-1.0)	0.339 ^{***}	(3.4)	0.081	(1.2)
CRE Tightening _{t-1}	-0.022	(-1.2)	0.958 ^{***}	(20.4)	-0.129	(-1.3)	-0.268 ^{***}	(-3.9)
Panel B. Four endogenous + exogenous controls								
<i>Dependent:</i>	<i>Income Returns_t</i>		<i>CRE Tightening_t</i>		<i>Volume_t</i>		<i>Capital Gains_t</i>	
Variable	Coef	(t-stat)	Coef	(t-stat)	Coef	(t-stat)	Coef	(t-stat)
Income Returns _{t-1}	0.965 ^{***}	(47.8)	-0.077 [*]	(-1.7)	0.208 [*]	(2.0)	0.051	(0.6)
Capital Gains _{t-1}	-0.144 ^{***}	(-5.8)	0.002	(0.0)	0.231 [*]	(1.8)	0.680 ^{***}	(7.0)
Volume _{t-1}	-0.022	(-1.1)	-0.066	(-1.4)	0.236 ^{**}	(2.1)	0.031	(0.4)
CRE Tightening _{t-1}	-0.033	(-1.5)	0.881 ^{***}	(17.7)	-0.338 ^{***}	(-2.9)	-0.273 ^{***}	(-3.2)
Baa _{t-1}	-0.001	(-0.5)	-0.005	(-1.0)	0.000	(0.0)	-0.001	(-0.1)
(R _M - R _F) _{t-1}	-0.023	(-1.2)	-0.158 ^{***}	(-3.8)	-0.095	(-1.0)	0.082	(1.1)
HML _{t-1}	-0.045 [*]	(-1.7)	-0.097	(-1.6)	0.240 [*]	(1.7)	0.083	(0.8)
SMB _{t-1}	-0.050 ^{**}	(-2.5)	-0.169 ^{***}	(-3.7)	-0.268 ^{**}	(-2.5)	-0.019	(-0.2)
(Baa - Aaa) _{t-1}	-0.009	(-0.6)	-0.016	(-0.4)	0.026	(0.3)	-0.046	(-0.7)
(10yr - 1yr) _{t-1}	0.036 ^{**}	(2.1)	0.022	(0.6)	0.013	(0.1)	-0.052	(-0.8)

Notes: This table presents results from two versions of the vector autoregressive model with four endogenous variables (VAR:4). The four endogenous variables are Income Returns, Capital Gains, Volume, and CRE Tightening – with results displayed sequentially from left-to-right. Panel A presents results from the first specification, where only endogenous variables are included. Panel B presents results from the model that also includes a set of exogenous controls for Baa rates, the Fama–French factors, the credit spread, and the yield curve. The table displays the estimated coefficients (Coef), along with the corresponding t-statistic in parentheses. All variables are defined in the notes to Table 1. ^{***}, ^{**}, and ^{*} indicate statistically significant coefficients at the 1%, 5%, and 10% levels respectively.

Table 5. Vector autoregressive model: Three endogenous variables (VAR:3)

Panel A. Three endogenous only						
<i>Dependent:</i>						
	<i>Income Returns_t</i>		<i>CRE Lending Index_t</i>		<i>Capital Gains_t</i>	
Variable	Coef	(t-stat)	Coef	(t-stat)	Coef	(t-stat)
Income Returns _{t-1}	1.000 ***	(57.0)	-0.141 **	(-2.4)	0.010	(0.2)
Capital Gains _{t-1}	-0.098 ***	(-4.9)	-0.127 *	(-1.9)	0.689 ***	(8.8)
CRE Lending Index _{t-1}	0.004	(0.2)	0.701 ***	(9.5)	-0.192 **	(-2.3)
Panel B. Three endogenous + exogenous controls						
<i>Dependent:</i>						
	<i>Income Returns_t</i>		<i>CRE Lending Index_t</i>		<i>Capital Gains_t</i>	
Variable	Coef	(t-stat)	Coef	(t-stat)	Coef	(t-stat)
Income Returns _{t-1}	0.969 ***	(44.5)	-0.154 *	(-2.0)	0.001	(0.0)
Capital Gains _{t-1}	-0.141 ***	(-5.5)	-0.152	(-1.7)	0.684 ***	(6.8)
CRE Lending Index _{t-1}	0.008	(0.3)	0.717 ***	(8.9)	-0.192 **	(-2.2)
Baa _{t-1}	-0.001	(-0.7)	-0.002	(-0.2)	-0.001	(-0.2)
(R _M - R _F) _{t-1}	-0.022	(-1.2)	0.026	(0.4)	0.107	(1.5)
HML _{t-1}	-0.059 **	(-2.4)	-0.040	(-0.5)	-0.058	(-0.6)
SMB _{t-1}	-0.037 **	(-2.0)	-0.026	(-0.4)	0.095	(1.3)
(Baa - Aaa) _{t-1}	-0.011	(-0.7)	-0.038	(-0.7)	-0.063	(-1.0)
(10yr - 1yr) _{t-1}	0.035 **	(2.1)	-0.001	(0.0)	-0.090	(-1.3)

Notes: This table presents results from two versions of the vector autoregressive model with three endogenous variables (VAR:3). The three endogenous variables are Income Returns, Capital Gains, and CRE Tightening – with results displayed sequentially from left-to-right. Panel A presents results from the first specification, where only endogenous variables are included. Panel B presents results from the model that also includes a set of exogenous controls for Baa rates, the Fama–French factors, the credit spread, and the yield curve. The table displays the estimated coefficients (Coef), along with the corresponding t-statistic in parentheses. All variables are defined in the notes to Table 1, except CRE Lending Index. CRE Lending Index is constructed from the principal components of the following four underwriting measures: Relative Tightening, CRE Tightening, Volume, and CRE Mtg Flows. ***, **, and * indicate statistically significant coefficients at the 1%, 5%, and 10% levels respectively.

Table 6. Variance decompositions

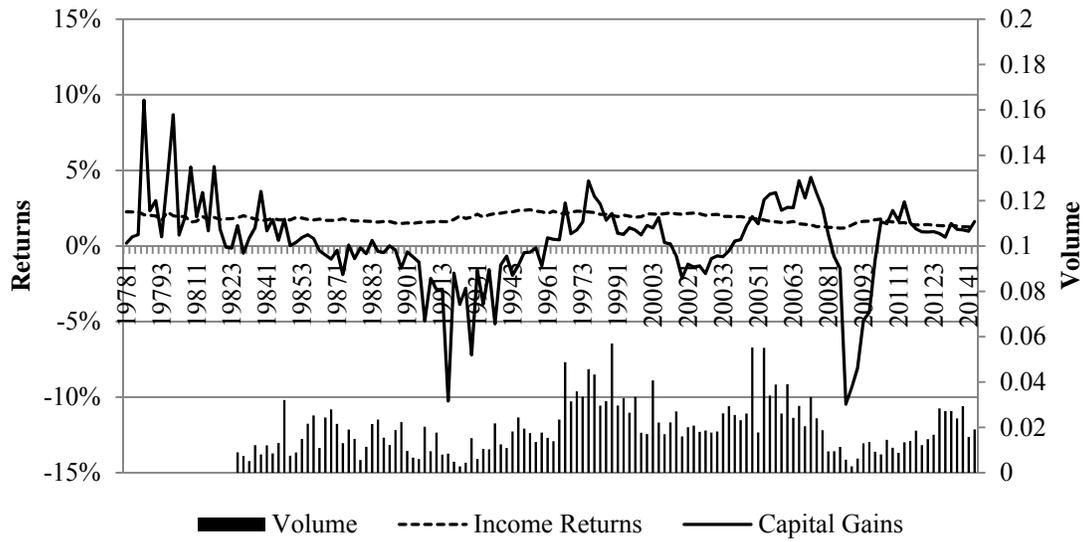
Panel A. VECM												
<i>Variance of:</i>	<i>Income Returns</i>			<i>CRE Tightening</i>			<i>Capital Gains</i>					
Forecast period:	4	8	12	4	8	12	4	8	12			
Income Returns	71%	51%	43%	0%	0%	0%	1%	1%	1%			
Capital Gains	28%	47%	54%	8%	17%	22%	96%	87%	78%			
CRE Tightening	1%	2%	2%	92%	82%	77%	3%	12%	21%			

Panel B. VAR:4												
<i>Variance of:</i>	<i>Income Returns</i>			<i>CRE Tightening</i>			<i>Capital Gains</i>			<i>Volume</i>		
Forecast period:	4	8	12	4	8	12	4	8	12	4	8	12
Income Returns	75%	56%	48%	0%	0%	0%	0%	0%	0%	2%	3%	4%
Capital Gains	20%	31%	28%	8%	15%	17%	76%	60%	56%	4%	5%	7%
Volume	5%	9%	10%	0%	0%	0%	9%	8%	7%	90%	82%	78%
CRE Tightening	0%	4%	14%	92%	85%	82%	15%	32%	37%	4%	10%	11%

Panel C. VAR:3									
<i>Variance of:</i>	<i>Income Returns</i>			<i>CRE Lending Index</i>			<i>Capital Gains</i>		
Forecast period:	4	8	12	4	8	12	4	8	12
Income Returns	74%	48%	35%	7%	11%	14%	0%	1%	3%
Capital Gains	23%	40%	47%	4%	5%	5%	84%	77%	75%
CRE Lending Index	3%	12%	18%	89%	85%	81%	15%	22%	22%

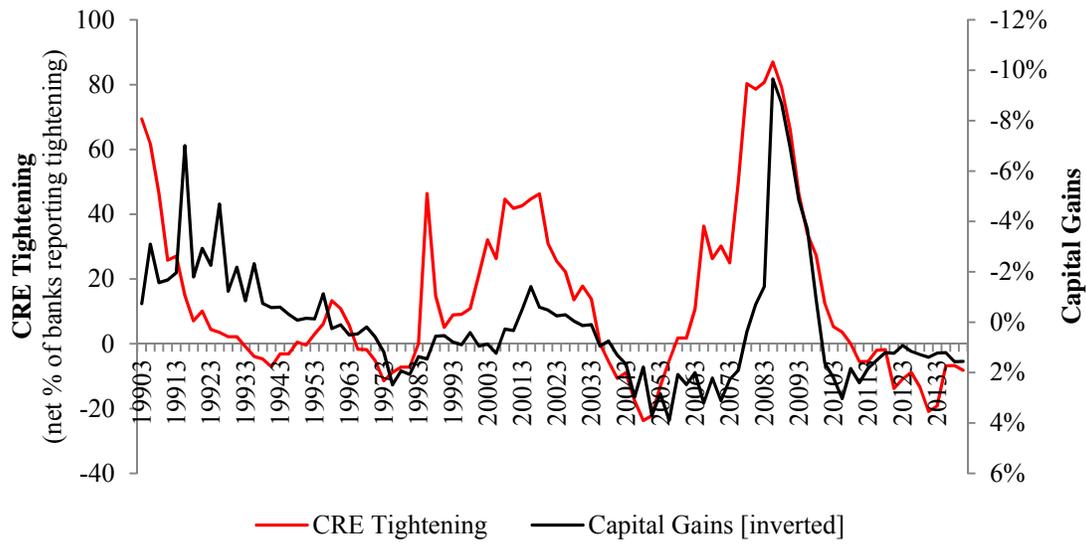
Notes: This table presents results from the variance decomposition for the percentage of forecast error variance of the predicted variable (in italics) that is explain by past realized values of the row variables. Panel A provides results for the VECM model (see Table 3, middle columns). Panel B provides results for the VAR:4 model (see Table 4, Panel A). Panel C provides results for the VAR:3 model (see Table 5, Panel A). In each Panel, variance decompositions are derived from the specification where only endogenous variables are included. The forecast period is quarters, and results are shown for the forecast error variance of 4, 8, and 12 quarters ahead. All variables are defined in the notes to Table 1, except CRE Lending Index (defined in notes to Table 5).

Figure 1. NCREIF data series, 1978Q1–2014Q2



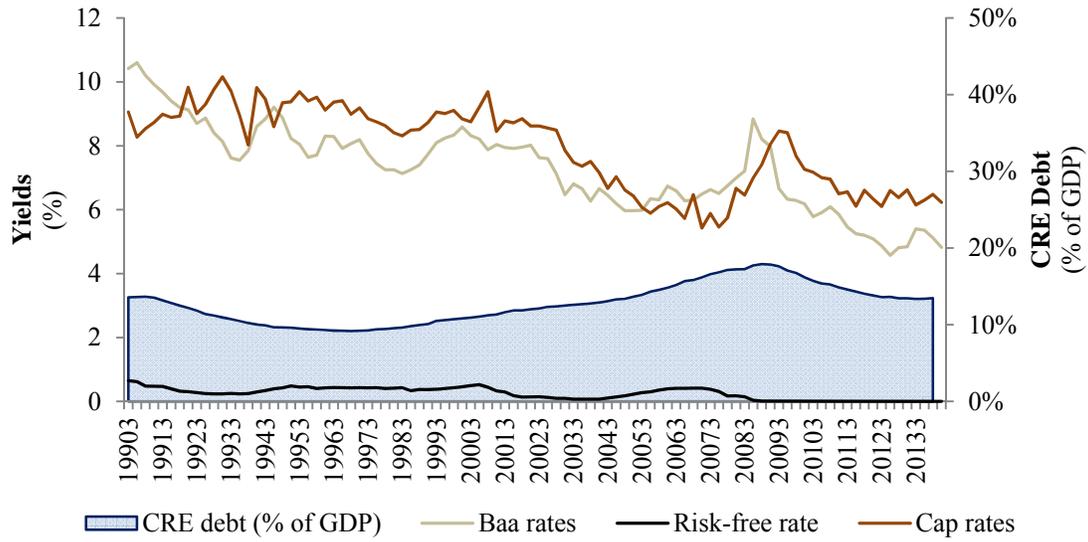
Notes: This figure plots quarterly values for Income Returns and Capital Gains (left-axis) along with Volume (right-axis) over the full time series of available data: 1978Q1-2014Q2. Capital Gains are depicted by the solid black line; Income Returns by the dashed black line. Volume is shown in black bars along the bottom. All variables are defined in the notes to Table 1.

Figure 2. CRE Tightening vs. Capital Gains [inverted]



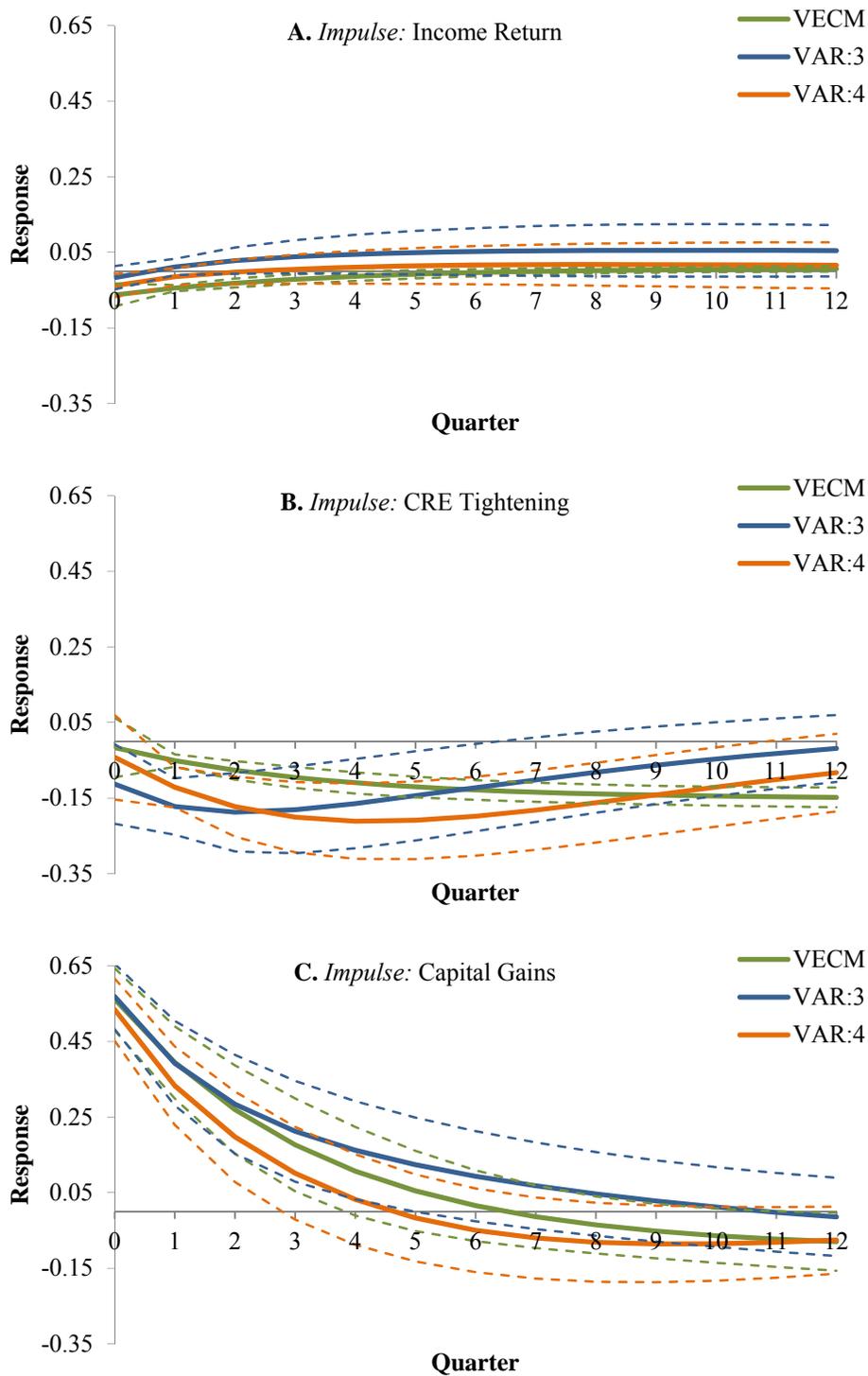
Notes: This figure plots quarterly values for CRE Tightening (left-axis) and inverted Capital Gains (right-axis) over the sample period considered in this study: 1990Q3–2014Q2. CRE Tightening is depicted by the solid red line; Capital Gains [inverted] by the solid black line. Both variables are defined in the notes to Table 1.

Figure 3. Interest Rates, Cap Rates, and CRE Debt



Notes: This figure plots quarterly values for Baa, R_F , and Cap Rates (left-axis), along with CRE Debt scaled by national GDP (right-axis), for the sample period considered in this study: 1990Q3–2014Q2. Baa is depicted by the solid grey line; R_F is the solid black line; Cap Rates are the solid brown line. CRE Debt (as a % of GDP) is represented in the shaded blue area. All variables are defined in the notes to Table 1.

Figure 4. Impulse response function of Capital Gains



Notes: The impulse response function is plotted for Capital Gains responding to a one standard deviation shock in Income Returns (Panel A), CRE Tightening (Panel B), and Capital Gains (Panel C). Response is measured in standard deviations over 12 quarters following the shock based on the specifications of VECM (green line), VAR:3 (blue line), and VAR:4 (orange line) that include only endogenous variables. Dashed lines represent \pm two standard errors of the forecast response.

Appendix Table A1. Alternate specifications, VAR:4 models

Panel A. Four endogenous only						
Alternate:	I		II		III	
Model:	<i>Capital Gains</i>		<i>Capital Gains</i>		<i>Capital Gains</i>	
Variable	Coefficient	(t-stat)	Coefficient	(t-stat)	Coefficient	(t-stat)
CRE Tightening _{t-1}	-0.287 ***	(6.9)	-0.285 ***	(-4.1)	-0.303 ***	(-3.9)
Capital Gains _{t-1}	0.576 ***	(-4.2)	0.588 ***	(7.2)	0.600 ***	(7.0)
Cap Rates _{t-1}	-0.080	(-1.3)				
Volume _{t-1}	0.089	(1.3)	0.101	(1.4)		
E{Income Returns} _{t+4}			-0.066	(-1.1)		
Income Returns _{t-1}					0.006	(0.1)
CRE Lending Index' _{t-1}					-0.105	(-1.4)

Panel B. Variance decompositions									
Alternate:	I			II			III		
Variance of:	<i>Capital Gains</i>			<i>Capital Gains</i>			<i>Capital Gains</i>		
Forecast period:	4	8	12	4	8	12	4	8	12
CRE Tightening _{t-1}	16%	34%	40%	15%	34%	39%	22%	40%	42%
Capital Gains _{t-1}	70%	54%	50%	67%	52%	48%	75%	56%	49%
Cap Rates _{t-1}	5%	4%	4%						
Volume _{t-1}	9%	7%	7%	11%	10%	9%			
E{Income Returns} _{t+4}				6%	5%	5%			
Income Returns _{t-1}							0%	0%	0%
CRE Lending Index' _{t-1}							3%	4%	9%

Notes: This table presents results for three alternative specifications of the VAR:4 model. In Alternate I, Income Returns is replaced by Cap Rates – collected from NCREIF for all property types and all regions. In Alternate II, Income Returns is replaced by its expected value, E{Income Returns} – which is the four quarter ahead forecast for Income Returns based on its autoregressive process with four lags and one moving average term. In Alternate III, Volume is replaced by CRE Lending Index' – constructed from the principal components of the four following underwriting measures: CRE Debt, Volume, CRE Mtg Flows, and CRE Spread. Panel A displays the parameter estimates (Coefficient), along with the corresponding t-statistic in parentheses. *** indicates statistically significant coefficients at the 1% level. Panel B displays the variance decompositions from these alternate estimations. The percentage of forecast error variance of Capital Gains that is explained by past realized values of the row variables is reported. The forecast period is quarters with results shown for the forecast error variance of 4, 8, and 12 quarters ahead. All estimations are for the specification with only endogenous variables included; the only results reported in the Table above are for the equation with Capital Gains as the dependent variable.

Appendix Table A2. Alternate data: Real Capital Analytics, VAR:4 models

Panel A. Four endogenous only						
Sector:	Office		Industrial		Retail	
Model:	<i>Capital Gains'</i>		<i>Capital Gains'</i>		<i>Capital Gains'</i>	
Variable	Coefficient	(t-stat)	Coefficient	(t-stat)	Coefficient	(t-stat)
NOI Growth	-0.032	(-0.7)	0.006	(0.1)	0.056	(1.0)
Capital Gains'	0.592 ***	(9.1)	0.688 ***	(11.7)	0.486 ***	(7.1)
Volume'	0.070	(1.4)	0.010	(0.2)	0.114 **	(2.3)
CRE Tightening	-0.295 ***	(-4.8)	-0.239 ***	(-4.3)	-0.315 ***	(-4.5)

Panel B. Variance decompositions									
Sector:	Office			Industrial			Retail		
<i>Variance of:</i>	<i>Capital Gains'</i>			<i>Capital Gains'</i>			<i>Capital Gains'</i>		
Forecast period:	4	8	12	4	8	12	4	8	12
NOI Growth	5%	7%	8%	3%	5%	6%	3%	3%	3%
Capital Gains'	69%	56%	52%	77%	62%	56%	68%	54%	48%
Volume'	4%	4%	5%	1%	2%	3%	3%	4%	5%
CRE Tightening	22%	32%	35%	19%	30%	34%	26%	39%	45%

Notes: This table presents results for estimations of the VAR:4 model using data from Real Capital Analytics (RCA) at the monthly frequency, which is available from December 2000 to March 2014 (160 observations). Estimations are provided for the Office, Industrial, and Retail sectors. NOI Growth, Capital Gains', and Volume' are measured for each property type. NOI is reported in the RCA database on a USD per square foot basis, and NOI Growth calculates the percentage change from the prior period. Capital Gains' measures the percentage change in the Moody's/RCA Commercial Property Price Index (CPPI) for the respective property type. Volume' provides a direct measure of the total dollar amount of transaction volume in a given sector, based on the RCA data. Panel A displays the parameter estimates (Coefficient), along with the corresponding t-statistic in parentheses. *** and ** indicate statistically significant coefficients at the 1% and 5% levels respectively. Panel B displays the variance decompositions from these alternate estimations. The percentage of forecast error variance for Capital Gains' that is explained by past realized values of the row variables is reported. The forecast period is quarters with results shown for the forecast error variance of 4, 8, and 12 quarters ahead. All estimations are for the specification with only endogenous variables included; the only results reported in the Table above are for the equation with Capital Gains' as the dependent variable.