The Cross-Sectional Dispersion of Commercial Real Estate Returns and Rent Growth: Time Variation and Economic Fluctuations *

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Abstract

We estimate the cross-sectional dispersion of returns and growth in net operating income (NOI) of apartments, industrial, retail and office properties using panel data for U.S. metropolitan areas over the period 1986 to 2002. Cross-sectional dispersion is a measure of the total volatility faced by investors in commercial real estate. To the extent that most of that volatility is difficult to diversify, cross-sectional dispersion may be an appropriate measure of risk. We document that for apartments, industrial, retail, and office properties, the cross-sectional dispersions are time-varying. Interestingly, their time series fluctuations can be explained by macroeconomic variables such as the term spread, default spread, inflation, and the short rate, which capture macroeconomic fluctuations. The total volatilities are counter-cyclical and also exhibit an asymmetrically larger response following negative return shocks, which might be due to leverage and credit channel effects. Finally, we find a positive relation between future returns and their cross-sectional dispersion. This total risk-return trade-off suggests that investors indeed demand compensation for being exposed to total volatility in the commercial real estate market.

1 Introduction

It is well documented that the volatility of equity returns varies over time at both the market and firm levels. Bollerslev, Chou, and Kroner (1992), Ghysels, Harvey, and Renault (1996), and Campbell, Lo, and MacKinlay (1997) provide good summaries of the extensive literature on time varying equity volatility and Campbell, Lettau, Malkiel, and Xu (2001) and Goyal and Santa-Clara (2003) offer new evidence of time variation of the total dispersion of individual stocks. However, comparatively little is known about the time variation in commercial real estate returns. The absence of empirical facts, however, is not due to a lack of interest by investors. On the contrary, the commercial real estate market represents a large fraction of the total U.S. wealth and its ownership is quite diverse. The best estimates put the value of the U.S. commercial real estate market at about $5 trillion in 1997 and $6 trillion in 1999, or between a third and a half of the U.S. stock market's value. Approximately half of these assets are held directly by households, proprietorships, partnerships, institutional portfolios and another quarter by corporations (Geltner and Miller (2000) and Case (2000)).

In this paper we focus on the total volatility of returns and growth in net rents (or net operating income (NOI)) of commercial real estate. It is well known that the values of commercial real estate properties are affected by geographic, demographic, urban, and local economic factors as well as by the overall state of the economy. To capture the total volatility of returns and growth in NOI, we compute their variation across metropolitan U.S. regions at a given point in time. For returns, the total volatility captures fluctuations due to common aggregate factors as well as idiosyncratic fluctuations related to local demographic, geographic, urban, or economic shocks. Similarly, the total volatility of the growth in NOI reflects market-wide as well as region-specific fluctuations.

We are mainly interested in the *time series properties* of the total volatilities of apartments, industrial, retail, and office returns and growth in their rents. In the commercial real estate market, the dynamics of the total volatilities are of economic importance for several reasons. First, commercial real estate is not an asset whose idiosyncratic fluctuations can be diversified away by holding a portfolio of many such assets. Unlike public equities and debt instruments, the commercial real estate market is characterized by the trading of whole assets, the value of each being a non-trivial share of most investors' portfolios. Hence, investors who hold commercial real estate might not have the opportunity to diversify away idiosyncratic fluctuations and will want to be compensated for being exposed to market-wide as well as region-specific real estate fluctuations.

Second, a considerable fraction of the commercial real estate is held both as an asset and as a necessary input of doing business. To see this, consider a retailer (or any other non-real estate related business) that owns properties as a part of their business operations. If prices of retail real estate double, then the value of the retail business has increased, but its cost of commercial real estate has increased by the same amount. There is no sense in which the retailer can profit from this increase in property prices unless it decides to close its operations. This is a risk that cannot be diversified away if the retailer is a privately held company. In the U.S., about 80% of the value of the total commercial real estate market is held privately (Geltner and Miller (2000)).[1]

Third, little is known about the total volatility of commercial real estate returns compared to other asset classes. What are their magnitudes in the case of apartments, industrial, retail, and offices? Are they time varying and if so, how persistent are their fluctuations? Are their time series properties dependent on the state of the overall economy? Or, are they mainly driven by local demographic, geographic, and urban trends? Since commercial real estate deals are highly leveraged, are there asymmetries in the cross-sectional dispersion? Our empirical analysis provides answers to these questions. This paper complements the work of Plazzi, Torous, and Valkanov (2004) who focus on variations in market-specific rather than total volatility of returns and growth in rents.

Whether these fluctuations translate into higher returns is a fourth reason for investigating the time variations of the cross-sectional dispersion of returns and growth in NOI. This question is directly related to an old debate in empirical finance of whether idiosyncratic risk is priced in the equities market. Early articles on the subject were by Lintner (1965) and Douglas (1969) while recent papers by Campbell, Lettau, Malkiel, and Xu (2001) and Goyal and Santa-Clara (2003) have rekindled this discussion. For the reasons discussed above, it is only natural to conjecture that total risk is priced in commercial real estate.

As a first step in our investigation, we estimate the cross-sectional dispersion of returns and growth in net rents of commercial properties across time. We use data on apartment, retail, industrial, and office properties across several U.S. metropolitan areas from 1986 to 2002 available at a bi-annual frequency. The data is from Global Real Analytics (GRA)

[1] In their book, Geltner and Miller (2000, Chap. 1) state that publicly traded non-real estate firms hold in excess of $1 trillion in real estate.

and offers a panel (metropolitan areas across time) of market-price indices for each of the four property types. At the aggregate level, the GRA data is similar to NCREIF's data, but has the advantage of offering indices for various regions and, in addition, its indices are constructed from market prices. While this database is not without its limitations, it is the most appropriate available data for our analysis.

We find that for all property types, the dispersion of returns and NOI growth varies significantly over the 1986 to 2002 period. For instance, the return variation of apartment, industrial and office properties is between 2.3% and 14.6% per year. Interestingly, the dispersions are time-varying and serially correlated. However, their serial dependence is not integrated, which suggests that the fluctuations are unlikely to be driven only by trends in demographic and geographic factors, which are persistent in nature. In fact, the time series properties of the cross-sectional dispersion are similar to those of economic variables, such as the term spread, default spread, inflation, and the three-month Treasury bill rate, which are often used to proxy for the state of the business cycle.

Following these observations, we conjecture that the cross-sectional dispersion is driven by fluctuations in these economic variables. In general, business cycle fluctuations can impact the dispersion of commercial real estate returns and NOI growth for two reasons. First, it is well known that the propagation and persistence of economic fluctuations differ across regions, because of differences in industry composition, firm size, and availability of funds across states (Carlino and DeFina (2003), Owyang, Piger, and Wall (2003), Fratantoni and Schuh (2003), Owyang and Wall (2004)). For instance, the 2001 recession was felt heavily in the San Francisco office market, which posted an annual return of -11.8% whereas office prices in other areas such as Oklahoma City increased by 11.5% during that period. If this reasoning is correct, we expect the cross-sectional dispersion to change with the economic conditions.

Consistent with our conjecture, we find that periods of high term and low default spreads (i.e., economic downturns) are correlated with subsequently higher cross-sectional dispersions of returns and NOI growth. This finding obtains even when we control for lagged values of the cross-sectional dispersion, which proxy for other, non-business-cycle-related fluctuations. In other words, in business-cycle troughs, cross-sectional variation increases. The results are consistent across property types, though the effect on the dispersion of apartments, industrial properties, and offices seems to be larger than for retail properties. Fluctuations that are anticipated by economic variables account for a significant fraction of the total variability. The counter-cyclicality that we document is reminiscent to that of the aggregate equity market (Schwert (1989)). However, it differs in two important respects. First, we are looking at a cross-sectional measure of total risk, rather than a measure of market risk. Second, we are considering an asset that is essentially privately held, less liquid, and less divisible than stocks.

The dependence of commercial real estate deals on external debt financing provides another possible connection between the state of the economy and the cross-sectional dispersion of returns and NOI growth. Commercial real estate investment is heavily reliant on leverage and the degree of leverage varies across U.S. regions (Lamont and Stein (1999), Schwartz and Torous (2004)). Moreover, it is well known that in economic downturns, external financing becomes costlier and scarce, because frictions, such as asymmetric information and costly enforcement of contracts, are also larger during those periods (e.g., Bernanke and Gertler (1989, 1995), Bernanke, Lown, and Friedman (1989)). Hence, the credit channel might act as an amplifier of business cycle fluctuations which makes recessions a particularly tumultuous time for commercial real estate. An implication of this argument is that negative economic shocks will lead to a larger increase in the cross-sectional dispersion of commercial real estate returns and growth in NOI. In other words, negative shocks will have an asymmetrically larger effect on the total volatility than positive shocks.

We test for the presence of asymmetries and find that the cross-sectional dispersion increases more following a negative shock to returns or growth in NOI. The asymmetry is statistically significant in three out of the four property types. The significance of our results is quite surprising given the low power of our tests.[2] The asymmetry test is in the spirit of Black (1976) who argues that the volatility of heavily leveraged companies will be impacted more by negative than positive shocks. In this paper, we show that the cross-sectional dispersion is similarly affected by negative shocks.

Since the documented fluctuations are difficult to diversify, it is important to investigate if investors in the commercial real estate market demand compensation for being exposed to this risk. We test whether higher cross-sectional dispersion leads to higher future returns in the market for apartments, industrial, retail, and office properties. Consistent with this total risk-return trade-off hypothesis, we find a positive forecasting relation between the cross-sectional dispersion and future returns. Moreover, in three out of the four property types,

[2] Unfortunately, more direct tests are not possible because it would require leverage data on the deals across time.

the trade-off coefficient is statistically significant. To put these results in perspective, the relation between risk and return has been difficult to establish in the equity market (Merton (1980), French, Schwert, and Stambaugh (1987), Glosten, Jagannathan, and Runkle (1993)). The fact that we find such a trade-off with a much shorter dataset gives us greater confidence that this relation actually characterizes commercial real estate markets.

It might be argued that the positive trade-off is due to time variation in expected returns, but is not necessarily a compensation for total volatility risk. To see this, recall that expected returns are time varying with the business cycle (Fama and French (1989), Keim and Stambaugh (1986), and for commercial properties, Plazzi, Torous, and Valkanov (2004)). In addition, we have shown that the cross-sectional dispersion also varies with the state of the economy. Hence, it might be argued that the positive relation between the returns of commercial real estate returns and the total volatility is due to the latter proxying for economic fluctuations. To investigate this possibility, we include other state variables to capture the time variation in the economic conditions. If the cross-sectional dispersion is merely a proxy for economic fluctuations, then the inclusion of these variables should all but eliminate the significance of the trade-off parameter. Another reason for including the state variables is that, from an ICAPM perspective, we must specify all variables that capture the changes in the investment opportunity set. However, with the additional economic variables, the total risk-return relation remains positive and significant for the same three property types.

The paper proceeds as follows. In section II, we describe the real estate data and the other economic variables used in the study. Section III presents the measures of cross-sectional dispersion as well as summary statistics and an analysis of their time series properties. Section IV links fluctuations in the total variation to economic variables that are known to proxy for the state of the economy. We also investigate asymmetries in the variation that might arise because of the high leverage in commercial real estate investments. In section V, we show that time series fluctuations in the cross-sectional dispersion are positively correlated with future returns of apartments, industrial, retail, and office properties. Section VI concludes.

2 The Data

2.1 Commercial Real Estate Data

Our commercial real estate data contains prices and annual cap rates (net rents as a fraction of price) of class A apartments, industrial, retail, and office properties for U.S. metropolitan areas (MSA). The data are provided by Global Real Analytics (GRA) and covers the period beginning with December 1985 (1985:12) and ending with March 2003 (2003:3). For the period 1985 to 1993, the data are available bi-annually and from 1994 onwards at a quarterly frequency. We have 21 metropolitan areas in 1985 and 23 from 1987 to 1988. From 1989 onwards, there are 48 metropolitan areas, and the number increases to 58 over the course of the sample. In the last ten years, our MSAs cover more than 70% of U.S. population (2000 data).

In order to use the larger 1985 to 2002 time span, we sample prices and CAP rates at a biannual frequency using all the available MSAs, and leave the subsample of quarterly observations for the 1994-2003 period as a robustness check in section 5. Given annual cap rates, CAP_t, and prices, P_t, of a particular property type in a given area, we construct net rents in that period as $H_t = \mathrm{CAP}_t P_{t-1}/m$, where m is the sampling frequency (so $m = 2$ for biannual data and $m = 4$ for the quarterly data used as robustness check). The gross returns $1 + R_t$ in quarter t are then obtained as $(P_t + H_t)/P_{t-1}$ while one plus the growth in rents is H_t/H_{t-1}. Our analysis will focus on the volatility of log excess returns, defined as $r_t = \ln(1 + R_t) - \ln(1 + R_t^{Tbl})$, where R_t^{Tbl} is the three-month Treasury bill yield, and on the volatility of log rent growth rates, $gh_t = \ln(H_t/H_{t-1})$. When there is no possibility of confusion, we refer to excess returns simply as returns.

An attractive feature of the GRA data is that it provides commercial real estate data across a wide cross-section of metropolitan areas. The cross-sectional aspect of the series is crucial to our study because we are interested in the dispersion of returns and growth in NOI across metropolitan areas. Another reason for using the GRA data is that it provides averages of transaction prices rather than appraisal values. While the GRA data must be used with some caveats (that we discuss next), we are not aware of any other sources that have market prices for as large a cross-section of metropolitan areas for a long enough time span.

There are several remarks that should be made regarding the GRA data. First, at a given point in time, the smaller metropolitan areas contain only between 50 and 100 properties. In our study this is not an issue because we are precisely interested in the total variation of real estate returns and growth in NOI. An ideal dataset would have data on the actual properties, rather than the metropolitan averages, but GRA would not release this data. Second, we do not have specific characteristics of the properties in and across metropolitan areas. For instance, we don't know if apartments in Los Angeles are directly comparable to those in Boston. However, this will always be an issue with aggregate data. Third, the data contains fewer areas between 1986 and 1988. Hence, our measures of the cross-sectional dispersion of returns and growth in NOI are noisier during the first three years of our sample and this would work against us in the empirical work.

To gain an idea of the properties of the data, we compare the excess returns of the GRA aggregate series (national averages) with the returns from NCREIF, which is an index based on appraisal data. The NCREIF index provides appraisal-based prices of apartment, industrial, retail, and offices at an aggregate level. Since returns of the NCREIF indexes are constructed by deducting the cost of management fees, we compare them with the GRA excess returns, that encompass a measure of the cost of capital. Another difficulty in comparing these two indexes might come from the definitions of the properties types, whose definitions are potentially different. For instance, our data refers to class A properties, while such distinction is not available in the NCREIF data within each property type.

Despite these and other differences, the two series share some common properties and display similar patterns during the 1986-2002 period. The GRA and NCREIF series are highly correlated with each other. The correlations range from about 70% for the retail properties to about 90% for industrial properties. The means of the two series are also very close; for offices, the two means are almost indistinguishable (5.0% of the NCREIF data and 4.6% for the GRA), while for apartments the means are slightly different (8.5% of the NCREIF data and 7.5% for the GRA). However, the average difference between the two series is always small and never exceeds 1%.

Turning to the serial correlation in the data, we estimate an AR(1) and AR(3) model for returns. The AR(3) model may be more appropriate at capturing short-term fluctuations in returns. The results from the AR(1) and the AR(3) models suggest that the GRA returns series exhibits less persistence than the NCREIF returns for all but apartments. For instance, if we compare the sum of the first three AR(3) coefficients for industrial properties and offices, the autocorrelation of the GRA data is much lower than the one of NCREIF (1.839 versus

2.124 and 1.660 versus 2.0283). This finding is consistent with the arguments in Geltner and Miller (2000, Chap. 25) that transaction-price indices exhibit less serial correlation than appraisal-price indices.

2.2 Macroeconomic Variables

The state of the overall economy at time t is captured by a vector of variables X_t. These variables are the term spread ($TSPR_t$), the default spread ($DSPR_t$), the CPI inflation rate (INF_t), and the three-month Treasury bill rate ($TB3M_t$).[3] The variables in X_t are widely used to capture the state of the economy and to model the time-varying behavior in aggregate stock market expected returns (Campbell and Shiller (1988a), Campbell (1991), Fama and French (1989), Torous, Valkanov, and Yan (2005) and, for a good review, Campbell, Lo, and MacKinlay (1997)). The term spread is defined as the difference between the yield on 10-year and 1-year Treasuries. The default spread is calculated as the difference between the yield on BAA- and AAA-rated corporate bonds. The CPI inflation is the quarterly growth in the CPI index. All these data, except the three-month Treasury bill rate, are from the FRED database. The three-month Treasury bill rate is obtained from Ibbotson Associates. The statistical properties of these variables are well known and are not provided here to save on space (see, e.g., Torous, Valkanov, and Yan (2005)). We will use X_t to investigate whether the time variation in the cross-sectional dispersion of returns and growth in NOI can be explained at least in part by fluctuations in the overall state of the economy.

3 Cross-Sectional Dispersion of Excess Returns and Net Operating Income Growth Rates

We denote by $R_{i,t+1}$ the return of a commercial property in metropolitan area i at time $t+1$ in excess of the three-month Treasury bill rate. There are N_{t+1} metropolitan areas at time

[3]We also tried using the consumption-wealth variable "cay," which Lettau and Ludvigson (2001) show forecasts future aggregate stock market returns. In the specification with the term spread, default spread, inflation, and the short rate, the cay variable was not significant.

$t+1$. The dispersion of a given property type's return across regions is

$$S_{r,t+1} = \sqrt{\sum_{i=1}^{N_{t+1}} (R_{i,t+1} - \overline{R}_{t+1})^2 / N_{t+1}}, \tag{1}$$

where $\overline{R}_{t+1} = N_{t+1}^{-1} \sum_{i=1}^{N_{t+1}} R_{i,t+1}$ is the given property type's average, or equally weighted portfolio return. Similarly, if H_{t+1} is a property's net operating income, (rent minus operating expenses, adjusted for vacancies) and $GH_{t+1} = \log(H_{t+1}/H_t)$ is its growth rate, then the cross-sectional dispersion of rent growth is

$$S_{gh,t+1} = \sqrt{\sum_{i=1}^{N_{t+1}} (GH_{i,t+1} - \overline{GH}_{t+1})^2 / N_{t+1}}, \tag{2}$$

where $\overline{GH}_{t+1} = N_{t+1}^{-1} \sum_{i=1}^{N_{t+1}} GH_{i,t+1}$ is the given property type's average growth in net rents across regions. We estimate $S_{r,t+1}$ and $S_{gh,t+1}$ for four property types, apartments, industrial, retail, and office properties, which we indicate with the superscripts apt, ind, rtl and off, respectively. Hence, we consider eight variables $S_{r,t+1}^{apt}$, $S_{r,t+1}^{ind}$, $S_{r,t+1}^{rtl}$ and $S_{r,t+1}^{off}$, and $S_{gh,t+1}^{apt}$, $S_{gh,t+1}^{ind}$, $S_{gh,t+1}^{rtl}$ and $S_{gh,t+1}^{off}$. For simplicity of notation, when we refer to the total variation of returns or growth in NOI of any property type, we will write $S_{r,t+1}$ or $S_{gh,t+1}$. The superscripts will be used only when we refer to a specific property type.

To better understand the variables $S_{r,t+1}$ and $S_{gh,t+1}$, suppose that at time $t+1$ we have two otherwise identical apartment properties, one in San Francisco, California and the other in Cleveland, Ohio. There is no reason to expect that their returns and growth in net rents will be identical or even similar, because the two metropolitan areas are exposed to different geographic, demographic, urban, and economic factors. Such factors are the primary determinants of the magnitudes, or levels, of $S_{r,t+1}$ and $S_{gh,t+1}$.[4] Cross-sectional dispersions will vary from period to period as long as the distributions of returns and the growth in NOI are time varying. It is well known that for other assets (including REITs), the conditional means and variances of returns and growth in net rents are time varying. Similarly, in this paper we estimate the time variability in commercial real estate returns and growth in NOI, document their time series properties, and analyze whether national

[4]Naturally, there is no such thing as two identical commercial properties in two different regions. Moreover, our data is aggregated at the metropolitan level. Hence, our measures of $S_{r,t+1}$ and $S_{gh,t+1}$ will be noisy. However, we have no reason to believe that there are systematic biases in the measurement of returns. The noise will only render our statistical procedures more conservative.

economic conditions account for the fluctuations.

We estimate $S_{r,t+1}$ and $S_{gh,t+1}$ using equations (1) and (2) for each of apartment, industrial, retail, and office properties. Panel A of Table 1 provides summary statistics of the eight time series variables expressed in annual percents. The average cross sectional volatility of excess returns is between 4.0% for retail and 7.0% for apartments. In comparison, the stock market's volatility is 14% while the average volatility of a typical stock is about 50% (e.g., Goyal and Santa-Clara (2003)). The volatility of real estate returns may be biased downward for two reasons. First, in the construction of the metropolitan area data, some of the risk has been diversified away. Second, the bi-annual data is much smoother than the stock market data which is available at daily or monthly frequencies. Geltner (1993) discusses the effect of temporal aggregation on the volatility of real estate returns. We also find that the average cross-sectional volatility of growth in NOI is between 3.5% for retail and 5.1% for offices and is always lower than the corresponding volatility of returns. Hence, our numbers can be interpreted as a lower bound on the volatilities of $S_{r,t+1}$ and $S_{gh,t+1}$.

Turning to the time series properties of $S_{r,t+1}$ and $S_{gh,t+1}$, we find that these variables fluctuate considerably over time, with standard deviations of between 1.2% to 2.5%. These standard deviations lie between the volatilities of the macroeconomic variables, also displayed in Table 1, which are between 0.2% and 1.7% and the volatility of a typical stock, which is about 9.5% (e.g., Goyal and Santa-Clara (2003)). The $S_{r,t+1}$ series also exhibit considerable persistence with AR(1) coefficients ranging from 0.259 for offices to as high as 0.748 for apartments. The AR(1) coefficients of the $S_{gh,t+1}$ series are in the range of 0.425 for offices to 0.707 for retail and are slightly less persistent, although not uniformly so across all types of properties. To put these numbers in perspective, the AR(1) coefficients of the macroeconomic variables are in the range of 0.322 to 0.952. Both $S_{r,t+1}$ and $S_{gh,t+1}$ exhibit some skewness and little kurtosis, with the exception of the office series.

The correlations between variables are displayed in Panel B of Table 1. Interestingly, the measures of $S_{r,t+1}$ for the various property types are not highly correlated. Also, the time series of $S_{gh,t+1}$ for the various properties are not highly correlated. However, we notice that for a given property type, $S_{r,t+1}$ and $S_{gh,t+1}$ are contemporaneously correlated. For instance, in the case of retail and offices, the correlations are 0.888 and 0.879, respectively.

Figure 1 plots the times series of $S_{r,t+1}$ and $S_{gh,t+1}$ for the four property types. As expected, we observe that the volatility of returns (solid line) is almost always higher than the volatility of NOI growth (dashed line). The graphs also show that returns and growth in NOI exhibit notable heteroskedasticity. For apartments, industrial, and offices, the $S_{r,t+1}$ and $S_{gh,t+1}$ series vary substantially. There are also clusters of particularly high volatility which is a feature of heteroskedastic processes. This observation is consistent with the corresponding large AR(1) coefficients in Table 1. Interestingly, for apartments and industrial properties, the increase in volatilities occurs in 1993-1994, whereas for offices it also occurs during 1997-1998 period.[5]

To summarize, the cross-sectional dispersion of commercial real estate returns and NOI growth are less volatile than individual stock returns, but part of that smoothness is due to cross-sectional diversification within a metropolitan area as well as to time series aggregation. The cross-sectional volatility is time-varying and exhibits serial correlation. The autocorrelations in $S_{r,t+1}$ and $S_{gh,t+1}$ are not as large as would be expected if they were driven solely by very low frequency fluctuations due to demographic and urbanization trends. Their time series properties are similar to those of economic variables that are often used to proxy for the state of the economy. Hence, the observed variations in $S_{r,t+1}$ and $S_{gh,t+1}$ might be due to changes in economic conditions, which is a hypothesis that we investigate next.

4 A Link Between the Cross-Sectional Dispersion and Economic Variables

The connection between commercial real estate prices and the state of the national economy is a natural one. A downturn in the economy with a corresponding reduction in employment and production will result in a decrease in the demand for office, retail, and industrial space, which will have a direct effect on occupancy rates and rents of commercial real estate. Overall economic conditions will also have an effect on the supply of real estate through the construction sector. A downturn in the economy will result in less construction starts and also in a slowdown of current construction, as builders wait out for a recovery in order to sell their properties. Case and Shiller (1989) make a similar argument for the housing market. A more indirect link between commercial property valuations and the macroeconomy is through the banking sector. Commercial real estate investors who are dependent on

[5] We verified that these large increases in volatilities are not driven by any one, two, or three outliers.

external debt financing will be impacted by fluctuations in interest rates (short rate, term spread, and default spread) which are particularly severe in an economic downturn (Bernanke (1983), Bernanke and Blinder (1983)). On the empirical side, there is evidence linking the macroeconomy and the aggregate commercial real estate market. Case (2000, p.135) provides convincing arguments for "the vulnerability of commercial real estate values to changes in economic conditions" while Case, Goetzmann, and Rouwenhorst (2000) link fluctuations in international commercial real estate markets to changes in GDP growth.

In this section, we investigate the connection between economic conditions and the cross-sectional dispersion of real estate returns and growth in NOI. We find that a significant fraction of time variation in cross-sectional dispersion documented in the previous section is correlated with lagged economic variables. The total volatility increases more following negative shocks, and this asymmetric response is consistent with the high leverage in commercial real estate deals.

4.1 Different Economic Shocks

Macroeconomic fluctuations affect not only the aggregate commercial real estate market but also the cross-section of commercial real estate values. It is well documented that the effect of macroeconomic shocks and their speed of propagation differs across metropolitan regions (Carlino and DeFina (2003), Carlino and Sill (2001), Owyang, Piger, and Wall (2003), Fratantoni and Schuh (2003), Owyang and Wall (2004)). These differences are linked to several factors, such as differences in industry composition, firm size, and availability of funds across states. Carlino and DeFina (2003) show that in general such industry composition differences are substantial and can lead to dramatic economic effects. On the empirical side, Carlino and Sill (2001) find considerable differences in the volatility of regional business cycles. Owyang, Piger, and Wall (2003) find that the depth of a recession and the speed of a recovery varies across states. In addition, Fratantoni and Schuh (2003) provide evidence that the effect of a Fed monetary policy shock differs across real estate markets. Owyang and Wall (2004)) link the difference in Fed policy shocks to differences in industrial composition and firm size.

Since macroeconomic conditions do not have the same effect on commercial real estate in all metropolitan areas, they will change the dispersion of returns and growth in NOI. To investigate the connection between the state of the national economy and variations in commercial real estate returns and growth in NOI, we run the following regressions for each property type:

$$S_{r,t+1} = \kappa_r + \gamma_r X_t + \phi_r S_{r,t} + \varepsilon_{r,t+1} \quad (3)$$

$$S_{gh,t+1} = \kappa_{gh} + \gamma_{gh} X_t + \phi_{gh} S_{gh,t} + \varepsilon_{gh,t+1}. \quad (4)$$

The parameters of interest are γ_r and γ_{gh}. The variables in X_t are the term spread, the default spread, inflation, and the three-month Treasury Bill rate. They are lagged by one period to prevent simultaneity problems in the estimation. Since these variables are persistent, it is well known that the estimates of γ_r and γ_{gh} will be biased if there is correlation between the innovations of X_t and the left-hand side variable (Stambaugh (1999)). However, from the correlation matrix in Table 1, we conclude that the correlations are not large, suggesting that the bias will be modest.[6]

We include an autoregressive term in the regressions for several reasons. First, from Table 1, we know that volatilities of assets are heteroskedastic. Second, we are interested in the marginal impact of economic variables in addition to other time series variations that might be due either to geographic, demographic, or urbanization trends, or to idiosyncratic shocks. Several authors have provided evidence of time variation in real estate prices and rents due to these factors. For instance, Abraham and Hendershott (1996) document a significant difference in the time series properties of house prices in coastal *versus* inland cities, while Plazzi, Torous, and Valkanov (2004) find a similar effect for commercial properties. If coastal properties become more valuable over time, then the dispersion will also change and it will not be due to prevailing economic conditions. Similarly, if there are demographic effects such as immigration, this may induce the cross-sectional dispersion of returns and growth in NOI to change over time. The lagged term controls for all such variations that are not accounted for by the X_t variable.

Table 2 displays the results. In Panel A, we show two estimated specifications of regression (3) for each property type. In this Table and in the rest of the paper Newey-West t-statistics with 4 lags are displayed in parentheses below the estimates. In the first specification, we consider only the effect of the economic variables in X_t by restricting $\phi_r = 0$, while in the second regression we estimate the unrestricted equation. We notice that the term spread (TSPR) has a positive sign in all regressions. Moreover, it is significant at least

[6]The Stambaugh (1999) bias adjustment is possible for only one predictor.

at the 5% level for all property types with the exception of retail properties when lagged $S_{r,t+1}$ is included. The default spread (DSPR) has a negative sign in all regressions and the coefficients are statistically significant at the 5% level for all property types but retail. Inflation (INF) has a statistically significant impact on the volatility of offices at the 1% level. For the other property types, the coefficients on inflation are mostly negative (the exceptions are industrial properties and retail, specification with a lag) but they are not statistically significant. The three-month Treasury bill rate (TB3M) has a positive effect on $S_{r,t+1}$ for all property types but the coefficients are significant only for apartments. The coefficients on lagged $S_{r,t+1}$ (LAG) are significant with t-statistics in excess of 3 for all property types but offices. This is in agreement with the AR(1) coefficients reported in Table 1, where offices are the only property type that does not display significant heteroskedasticity.

Panel B of Table 2 displays the estimates of regression (4) for all property types. The estimates of TSPR are positive and significant in all but one regression. However, they are lower in magnitude than the coefficients in Panel A. Similar conclusions emerge for the estimates of DSPR, CPI, and TB3M in that their signs generally agree with those in the volatility of returns equation, but their magnitudes are somewhat lower. Interestingly, the corresponding coefficients in Table 2 are, in general, consistent across property types, which is another indication that the overall economic fluctuations have a systematic effect on the volatility of commercial real estate returns and growth in NOI.

The signs of TSPR and DSPR suggest that in periods of a large term spread and a small default spread, expected $S_{r,t}$ and $S_{gh,t}$ are high. Since it is well documented that the term spread is largest and the default spread is smallest in a business cycle trough and both variables precede an economic recovery (e.g., Fama and French (1989), Campbell, Lo, and MacKinlay (1997)), the evidence in Table 2 suggests that the expected values of $S_{r,t+1}$ and $S_{r,t+1}$ are counter-cyclical. In other words, the cross-sectional volatility of returns and NOI growth are largest in a recession and smallest in an expansion. Schwert ((1989), (1990)) observes the same counter cyclical behavior of the aggregate market volatility of equities. While it is interesting to note that both volatilities have the same correlation with the business cycle, one is a cross-sectional dispersion and not an aggregate market volatility.

The estimates in Table 2 imply that the macroeconomic variables have an economically meaningful effect on the cross-sectional volatilities. The economic impact of the macroeconomic variables is easy to interpret since the left- and right-hand side variables are both in percents. For instance, in Panel A, specification (1) for apartments, a two standard deviation increase in the term spread is associated with a 4.4% (2×1.1×2.077) subsequent increase in the cross sectional dispersion of apartment returns.[7] Since the unconditional mean of the dispersion is 7% (Table 1), this corresponds to an increase of 62.9%. Table 3 displays the marginal economic significance for all variables across property types. The first entry in each cell is the economic significance computed as 2 times the standard error of the regressor times its coefficient and corresponds to the response of the dispersion to a two standard deviation shock in the variable. The second entry is the absolute value of the response divided by the average volatility and represents the marginal response as a fraction of the volatility. The marginal economic impact of the variables is computed for the regressions with and without a lagged volatility term, as in the previous table.

The results in Table 3 suggest that the term spread captures the largest fraction of the variation in $S_{r,t+1}$. Across property types, a two standard deviation shock to the term spread in specification (1) results in an increase in $S_{r,t+1}$ in the range of 1.3% (retail) and 4.4% (apartments). This corresponds to between 31.2% and 62.9% of the total variability of $S_{r,t+1}$. The default spread and the Treasury bill rate also have an economically important impact in specification (1), while inflation is only economically important for office properties. This is undoubtedly due to the fact that we consider excess rather than nominal returns. We observe very similar results for the $S_{gh,t+1}$ regressions. The inclusion of the lagged terms lowers the economic significance numbers, especially for retail properties.

As conjectured above, the observed effect of economic variables on the cross-sectional variation might be driven by differences in the propagation of economic shocks across regions. Naturally, understanding the link between these two variables would require a structural model. There might be cross-sectional differences in the characteristics of properties that would lead to fluctuations in the cross-sectional dispersion in the absence of such differences. We elaborate on and test this hypothesis in the next section.

4.2 Leverage and Asymmetric Volatilities

Because most commercial real estate deals are highly leveraged and the degree of leverage varies across regions, aggregate economic shocks can affect the cross-section of commercial real estate valuations even if they have the same effect across regions. To see this, suppose that the same negative shock affects two metropolitan areas, and that the office properties

[7] The standard deviations of the macroeconomic variables are from Table 1.

are leveraged in one area and not in the other. In an economic downturn, the cost of external debt financing increases in absolute terms and also relative to internal financing. Bernanke and Gertler (1989), Bernanke, Lown, and Friedman (1989), and Bernanke and Gertler (1995) note that what is known as the credit crunch arises because credit market frictions, such as asymmetric information and costly enforcement of contracts, are amplified during those periods. The increased cost of external financing makes it costlier to invest in the highly leveraged office area relative to the non-leveraged area. As a result, returns and growth in NOI in the two regions will reflect the increased cost of leverage and their cross-sectional dispersion will increase.

The leverage effect introduces an asymmetry into the response of the total volatility to economic fluctuations. Namely, negative shocks produce a larger increase in the cross-sectional dispersion than positive shocks. Hence, if our conjecture of a leverage effect is correct, we expect to see a larger response of $S_{r,t+1}$ and $S_{gh,t+1}$ following negative economic shocks. Black (1976) discusses a similar leverage hypothesis which is most often used to explain asymmetries in the volatility of the aggregate equity market.[8] Following Black (1976), we will use lagged returns in the asymmetry tests, because the response of the commercial real estate market to economic fluctuations is the best mechanism to identify positive and negative shocks.

The leverage hypothesis is particularly important to account for the cross-sectional dispersion in real estate returns for several reasons. First, commercial real estate deals are highly leveraged. This is in contrast to the equity markets where realistic leverage levels are much lower, which has led some authors to question the empirical importance of Black's (1976) leverage hypothesis (Christie (1982), Schwert (1989), and for a review, Campbell, Lo, and MacKinlay (1997, p.497)). In the market for apartments, industrial, retail, and offices, the leverage argument is far easier to understand. Moreover, its economic impact might be sizable as shown by Lamont and Stein (1999).

Second, to the extent that leverage varies across metropolitan areas, it can produce variation in the cross-section of property returns and NOI growth. Indeed, there is evidence that the degree of leverage varies substantially across metropolitan areas. Lamont and Stein (1999) provide direct evidence for the housing market and show and that the impact of a shock increases with the leverage. Cannaday and Yang (1996) argue that leverage

[8] However, Black's hypothesis does not rely on imperfection in the external debt financing market and cannot easily generate cross-sectional asymmetries.

should depend on investor characteristics, which might also vary across MSAs. In addition, Schwartz and Torous (2004) document substantial U.S. cross-sectional differences in rent growth rates (between -1% and 11%), vacancy rates (between 4% and 22%), and volatility of rents (between 3% and 18%). Because leverage is a function of these variables, this also supports the notion that it varies across regions.

Third, while a direct test of the leverage hypothesis necessitates leverage data that is difficult to acquire, Black's (1976) observation about the resulting asymmetric effect of negative shocks is applicable to cross-sectional volatilities as well. In other words, if negative shocks have an asymmetrically larger effect on the cross-sectional variation of returns and growth in rents, this can be interpreted as evidence consistent with the leverage hypothesis.[9]

To consider the possibility of an asymmetric response of the cross-sectional dispersion, we run the following regressions:

$$S_{r,t+1} = \kappa_r + \gamma_r X_t + \phi_r S_{r,t} + \delta_r d_{r,t} + \varepsilon_{r,t+1} \quad (5)$$

$$S_{gh,t+1} = \kappa_{gh} + \gamma_{gh} X_t + \phi_{gh} S_{gh,t} + \delta_r d_{gh,t} + \varepsilon_{gh,t+1} \quad (6)$$

where $d_{r,t}$ is a dummy variable that equals one when the return of the portfolio return of properties of a certain type over the last three periods is greater than its time series mean. Similarly, $d_{gh,t}$ is a dummy variable that equals to one when the average NOI growth of properties of a certain type is greater than its time series mean over the last three periods. The dummies proxy for the positive (and negative) shocks in the real estate market of each property. The sign and significance of the coefficients δ_r and $\delta_{gh,t}$ capture the asymmetries in the time series of $S_{r,t}$ and $S_{gh,t}$.[10]

Equations (5) and (6) are similar to Glosten, Jagannathan, and Runkle's (1993) test for asymmetry in systematic risk measures, but in the present context, we consider asymmetries in the cross-sectional volatility. We include the variables in X_t to control for time variation in the state of the economy, as in the previous section. The estimates on the dummy variables

[9]An alternative hypothesis that might generate the asymmetry is Campbell and Hentschel's (1992) volatility feedback model. While in our context the volatility feedback is more difficult to understand than the leverage hypothesis, there is no good way of testing one against the other.

[10]The same tests can be formulated in a GARCH-type model by allowing the conditional variance to depend on past shocks on expected returns.

will be interpreted as the difference in the cross-sectional dispersion following a positive shock.

Table 4 reports the results of regressions (5) and (6). The coefficient estimates on the dummy variables are always negative, which implies that positive shocks have a smaller effect on the volatilities. In the $S_{r,t+1}$ regressions, a negative shock results in the cross-sectional dispersion being between 0.4% (retail) and 2.8% (offices) higher than for positive shocks. These numbers are quite large economically, if we recall that a typical fluctuation (i.e. one standard deviation) of $S_{r,t+1}$ is about 2%.[11] For apartments, industrial, and office properties, the asymmetry is statistically significant at the 5% level. Similar, albeit smaller, numbers obtain for the $S_{gh,t+1}$ regressions. For these regressions, we notice that apartments, retail, and office properties are statistically significant at the 5% level.

Accounting for the asymmetries improves the fit of most regressions. For offices, in particular, the adjusted R^2s double with the inclusion of the dummies. This is quite interesting, as there is evidence that the cash flows of office properties are the riskiest and most volatile. For instance, commercial mortgage-backed securities collateralized by office buildings are viewed as being a riskier investment than securities collateralized by the other three property types.[12] In our data, the mean and standard deviation of $S_{gh,t}^{off}$ are the highest (Table 1), which is consistent with these claims. Since the volatility of cash flows has a direct impact on leverage ratios, offices are likely to be most sensitive to positive and negative shocks, which matches well with our results in Table 4.

4.3 Robustness Checks

Robust Measure of Dispersion

The results in the previous section relied upon the standard deviation at a point in time as a measure of the cross-sectional dispersion in both excess returns and rent growth. The use of the standard deviation has several theoretical motivations and allows us to interpret the results in terms of percentage units. However, it has the drawback that its value can be highly affected by outliers, as it is evaluated using the squares of the deviations from the average. Since the number of MSAs available in our database is not constant through time

[11] In Table 1, the standard deviations of $S_{r,t+1}$ are between 1.2% and 2.5%. The standard deviations of $S_{gh,t+1}$ are slightly lower, between 1.2% and 1.7%.

[12] See, Duff and Phelps Credit Rating Co., The Rating of Commercial Mortgage-Backed Securities, 1999.

and we have only 21 observations for the first two years, it is appropriate to check whether our results capture truly time-varying dynamics or whether they are instead driven by a few outliers. This, for example, could happen if during our sample period a few areas are affected by persistent idiosyncratic shocks that drive the returns far from their long-run means, thus increasing the kurtosis of the sample and the cross-sectional standard deviation.

In order to control for the presence of outliers, we define a different measure of dispersion for excess returns

$$V_{r,t+1} = \sqrt{\sum_{i=1}^{N_{t+1}} |R_{i,t+1} - \overline{R}_{t+1}|/N_{t+1}} \tag{7}$$

and similarly for rent growth

$$V_{gh,t+1} = \sqrt{\sum_{i=1}^{N_{t+1}} |GH_{i,t+1} - \overline{GH}_{t+1}|/N_{t+1}}. \tag{8}$$

These measures use the absolute value as a measure of distance in place of the quadratic function and will be less susceptible to outliers. In what follows, we will refer to it as the "absolute dispersion" measure.

To test the impact of outliers, we re-estimate regression (3) and (4) using the absolute dispersion for the 1986-2002 period. Table 5 reports the estimated coefficients and goodness of fit measures. If we compare these results with those of the second specification in Table 2, we see that they lead to the same conclusions. The economic variables remain significant with the term and default spread being the most significant. The signs of the estimated coefficients are consistent with the previous tables. Namely, a positive effect for the term spread and a negative effect for the default spread for both the absolute dispersions of excess returns and rent growth. It is also worth noting that the coefficients of the economic variables have in general almost doubled. For example, in the regression of the absolute dispersion of excess returns of apartments, the coefficient for the term spread is 1.9 (with a t-statistic of 2.1) and for the default spread is -5.6 (with a t-statistic of -2.8), while the same values using the standard deviation they are 1.2 (with a t-statistic of 2.0) and -2.8 (with a t-statistic of -2.5) respectively. The coefficients of the lagged absolute dispersion are comparable to those of the lagged volatility, and the t-statistics are in general higher when using the absolute dispersion. The R^2_{adj} have very similar magnitudes and vary in the same range as previously, with values on the order of 55% for apartments (regression of $V_{r,t+1}$), industrial and retail properties (regression of $V_{gh,t+1}$).

Table 6 shows the results of the regressions (5) and (6) when using the absolute dispersion measure with asymmetries. Again, we see that the use of a different measure of dispersion does not alter our previous findings. The dummy variable enters the regressions with a negative coefficient that is significant for the same properties as in Table 4. Its inclusion leads to a general increase in the R^2_{adj}. Again, offices display the highest increase in the goodness of fit. Consistently with the above results, the inclusion of the dummy variable does not change the significance of the conditioning variables which display essentially the same magnitudes and t-statistics as in Table 5.

From all this evidence, we conclude that the time varying pattern in cross-sectional dispersion is not the result of a few outliers and that our findings do not appear to depend on the definition of the variability measure.

Sampling Frequency and Aggregation

The data is available bi-annually from 1986 to 1993 and quarterly from then on. As a result, for the entire sample, we sampled the data bi-annually in order to gain comparable results. Taking such a long time span might however induce smoothing which is due to the temporal lag in the data. Geltner (1991), Geltner (1993), and Geltner and Miller (2000) show that temporal lags and aggregation will induce artificial smoothing in the time variability of the returns series.

As a robustness check to address this aggregation issue, we re-run regressions (3) and (4) using quarterly data for the 1994 to 2003 sample period. While the number of observations does not change, we have halved the previous time period and doubled the frequency. The shorter sample excludes the late 1980s and early 1990s, which were highly volatile periods, as shown in Figure 1. However, the higher frequency subsample allows us to investigate the impact of time-aggregation on our results.

Table 7 reports the estimates for a forecasting interval of two quarters. The forecasting horizon is chosen in order to obtain results comparable with the previous ones. The conditioning economic variables are once again significant and the sign of the default spread coefficient is consistently negative. The lagged volatility is less significant than before, and this is not surprising since the volatility seems to be less persistent during this period. The evidence of time-varying volatility is still present, although, in general, the coefficients are less significant than in the longer database, which reflects the shorter time span and the lower power of the statistical tests.

5 Expected Returns and the Cross-Sectional Variation of Returns

Thus far, we have documented substantial time variation in the cross-sectional dispersion measures $S_{r,t}$ and $S_{gh,t}$. Even more interestingly, we found that variables that proxy for the state of the economy forecast future $S_{r,t}$ and $S_{gh,t}$. Taken together, the evidence points to the total volatility of commercial real estate being time varying and that this variation is linked to economic fundamentals. The focus on total volatilities $S_{r,t}$ and $S_{gh,t}$ is more appropriate for commercial real estate markets, because, as argued earlier, diversification and hedging is much difficult for a portfolio of real estate properties, which are inherently illiquid, cannot be shorted, are most often privately held, and with no available derivative contracts written on them.

These arguments suggest that investors will demand compensation for being exposed to the total volatility of commercial real estate returns and NOI growth. In other words, we conjecture that investors demand higher returns in periods when expected total volatility is higher. To test the total risk-return trade-off hypothesis in commercial real estate, we run the following regression for all property types:

$$R_{t+1} = \alpha + \beta\, R^M_{t+1} + \psi\, S^2_{r,t} + \varepsilon_{t+1} \tag{9}$$

where R_{t+1} is a portfolio return of a property type across regions, R^M_{t+1} is the return of the aggregate stock market, and $S^2_{r,t}$ is the cross-sectional variance of returns. Regression (9) implies that, in addition to market risk, the total cross-sectional variance is a second risk factor in a Merton (1973) ICAPM framework. A priori, we expect the estimates of β to be close to zero, as it is well known that real estate investments have a very low beta with respect to the market (Case and Shiller (1989), Case (2000)).

In addition, we expect the estimate of ψ to be positive under the conjecture that investors demand higher expected real estate returns in periods when the total cross-sectional variance is high. In the regressions, we use the variance rather than the volatility, because this is the customary specification in the risk-return literature (Merton (1980), French, Schwert, and Stambaugh (1987), Engle, Lilien, and Robins (1987), Ghysels, Santa-Clara, and Valkanov (2004)). The specifications with volatility (omitted for brevity) yield very similar results.

Table 8 displays the estimates of regressions (9). We use the S&P 500 return as a proxy for the market return. The estimates of ψ are all positive. The corresponding Newey-West t-statistics are larger than 2.4 for three of the four property types (which corresponds to a statistical significance of at least 1.6%), the exception being industrial properties, where the coefficient is not statistically significant. The R^2 for apartments, industrial, retail, and offices are 0.218, 0.135, 0.210, and 0.118, respectively. In general, our findings confirm the presence of a positive cross-sectional risk-return relation in the commercial real estate market.

The results in Table 8 deserve some further comments. First, the estimates of β are in the range of -0.004 to 0.043. These estimates are not significantly different from zero at conventional levels. Hence, there seem not to be a significant correlation between the real estate and the stock markets. This finding is in line with the findings of Case and Shiller (1989).

Second, regressions that estimate a relation between future returns and measures of risk usually do not find a positive and statistically significant coefficient (e.g., Campbell (1987), French, Schwert, and Stambaugh (1987), Turner, Startz, and Nelson (1989), Baillie and DeGennaro (1990), Campbell and Hentschel (1992), Glosten, Jagannathan, and Runkle (1993), and Whitelaw (1994)). Goyal and Santa-Clara (2003) also document a negative aggregate risk-return trade-off. Recently, Ghysels, Santa-Clara, and Valkanov (2004) document a positive risk-return relation for the aggregate market. They show that in regressions such as (9), it is important to have a long enough forecasting horizon as a proxy for expected returns. In our regressions, the six-month returns seem to be a good proxy for expected returns.

Third, it might be argued that while our results in Table 8 are consistent with time varying expected real estate returns, they are not necessarily due to the pricing of cross-sectional variation. Campbell and Shiller (1988b), Fama and French (1989), Keim and Stambaugh (1986) and others show that expected returns of stocks and bonds vary with the state of the economy and Plazzi, Torous, and Valkanov (2004) document the same result for commercial real estate. Previously, we found that $S^2_{r,t}$ also varies with the state of the economy. Hence, the forecasting relation in regression (9) might be due to the cross-sectional variation being a proxy for time variation in the economy. To address this concern, we include other economic variables that proxy for business cycle fluctuations. With these variables in the regression, the coefficients on $S^2_{r,t}$ must turn insignificant, if our previous results are driven by a proxying effect.

A related argument for including additional economic variables is provided by Scruggs (1998) who shows that in an ICAPM setting, it is important to include all variables that characterize changes in the investment opportunity set. Otherwise, regressions such as (9) will suffer from omitted variables bias. To address these issues, we run the following regression

$$R_{t+1} = \alpha + \beta\, R^M_t + \psi\, S^2_{r,t} + \chi Z_t + \varepsilon_{t+1} \tag{10}$$

where Z_t is a set of conditioning information. Similarly to Scruggs (1998), we use the default spread as an additional state variable. We also tried the term spread, inflation, and the three-month Treasury bill rate, but they were insignificant and the estimates of ψ were very similar.[13]

The results from this regression are shown in the second panel of Table 8 for all property types. Conditioning on the default spread has little effect on the estimates of ψ which remain positive. For apartment, retail, and offices, the coefficients are statistically significant at least at the 10% level. The statistical significance of the results is quite remarkable given the small sample and the lack of power of our tests. We conclude that our results are consistent with Plazzi, Torous, and Valkanov (2004) who argue that expected returns of commercial properties are time-varying. However, the significance of $S_{r,t}$ in the risk-return relation is not merely driven by it proxying for fluctuations in the state of the economy.

In sum, we find a positive and significant relation between commercial property returns and their cross-sectional dispersion. Given the small sample size, the statistical significance of the results is quite encouraging.

[13] Scruggs (1998) uses the yield of the long bond rather than the default spread.

6 Conclusion

In this paper, we estimate the cross-sectional dispersions of commercial real estate excess returns and growth in rents. Using panel data on U.S. metropolitan areas over the 1986-2002 period, we analyze the time-series properties of the dispersions for apartments, industrial, retail, and office properties. We find that these volatilities are time-varying and persistent. More importantly, their fluctuations are forecasted by the term and default spreads, and, to a lesser extent by inflation and the three-month Treasury bill rate. The dispersions are counter-cyclical, increasing in recessions and decreasing in expansions. The fluctuations are asymmetrically larger following negative shocks to returns. We suggest that the observed asymmetry may be due to high leverage and the sensitivity of commercial real estate to external debt financing.

The fluctuations in the cross-sectional dispersion are positively related to future commercial real estate returns. This is evidence that in periods of high total volatility, investors expect higher excess returns to invest in commercial real estate. The positive total risk-return trade-off is consistent with our conjecture that investors demand compensation for being exposed to total volatility, because most of that volatility is difficult to diversify across commercial real estate markets.

Our paper raises several interesting issues. First, while the fluctuations of the cross-sectional dispersion are linked to aggregate economic conditions, we do not provide direct evidence of the transmission mechanism from the macroeconomic shocks to regional commercial real estate markets. Similarly, while the asymmetric response of the total volatility is consistent with the leverage conjecture, we provide only indirect evidence linking external debt financing and commercial real estate returns. An interesting direction for further research would be to design more direct tests of these economic channels using disaggregated data. Unfortunately, such a dataset was not available to us.

Another interesting question is whether a positive relation between the total volatility and return is present in real estate investment trusts (REITs). One of the most important features of REITs is that they allow investors to hold a more diversified real estate portfolio. To the extent that our results are driven by the difficulty to diversify, the results in the REIT markets should be weaker.

Finally, our results underscore the importance of heterogeneity in commercial real estate valuation. The pricing of commercial real estate is an open question, mainly because of the presence of this heterogeneity. Hopefully, the findings in this paper will provide some of the facts needed for future work in this area.

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Table 1: Descriptive Statistics of Excess Returns Volatility, Rent Growth Volatility and Conditioning Variables

The table reports descriptive statistics of excess returns volatilities (as defined in equation (1)), rent growth volatilities (as defined in equation (2)) and economic variables. The economic variables are defined as follows: $TSPR$ is the difference between the yield on 10-year and 1-year Treasuries, $DSPR$ is the difference between the yield on BAA and AAA rated corporate bonds, INF is inflation computed as the growth of the CPI index and $TB3M$ is the three-months Treasury bill rate. Panel A reports the mean, the standard deviation (denoted by Std), the AR(1) coefficient, the sum of the first 3 autocorrelation coefficients ($AR(1-3)$), the coefficients of skewness ($Skew$) and kurtosis ($Kurt$), the minimum (Min) and maximum (Max) value in the sample. Panel B shows the autocorrelation matrix. The sample is biannual observations from 1986:6 to 2002:12.

Panel A: Descriptive statistics

$Variable$	$Mean$	Std	$AR(1)$	$AR(1-3)$	$Skew$	$Kurt$	Min	Max
Volatility of Excess Returns								
$S_{r,t}^{apt}$	0.070	0.025	0.748	1.799	1.080	3.365	0.036	0.132
$S_{r,t}^{ind}$	0.057	0.020	0.635	1.341	0.729	2.925	0.030	0.109
$S_{r,t}^{rtl}$	0.040	0.012	0.709	1.431	0.307	2.196	0.023	0.070
$S_{r,t}^{off}$	0.062	0.025	0.259	0.434	1.289	5.082	0.028	0.146
Volatility of Rent Growth								
$S_{gh,t}^{apt}$	0.049	0.014	0.466	0.951	0.651	2.791	0.026	0.083
$S_{gh,t}^{ind}$	0.042	0.014	0.676	1.549	0.307	2.464	0.016	0.071
$S_{gh,t}^{rtl}$	0.035	0.012	0.707	1.210	0.115	2.533	0.013	0.058
$S_{gh,t}^{off}$	0.051	0.017	0.425	0.395	0.757	3.227	0.023	0.098
Conditioning variables								
$TSPR$	0.018	0.011	0.780	1.211	0.075	1.914	-0.003	0.036
$DSPR$	0.009	0.002	0.851	1.958	0.570	2.113	0.006	0.014
INF	0.030	0.014	0.322	0.871	-0.042	3.511	-0.004	0.064
$TB3M$	0.050	0.017	0.952	2.089	-0.164	2.853	0.014	0.084

Table 1 (Cont'd): Descriptive Statistics of Excess Returns, Growth in Rents and Conditioning Variables

Panel B: Correlation matrix

	$S_{r,t}^{apt}$	$S_{r,t}^{ind}$	$S_{r,t}^{rtl}$	$S_{r,t}^{off}$	$S_{gh,t}^{apt}$	$S_{gh,t}^{ind}$	$S_{gh,t}^{rtl}$	$S_{gh,t}^{off}$	$TSPR_t$	$DSPR_t$	INF_t	$TB3M_t$
$S_{r,t}^{apt}$	1											
$S_{r,t}^{ind}$	0.740	1										
$S_{r,t}^{rtl}$	0.764	0.650	1									
$S_{r,t}^{off}$	0.569	0.661	0.523	1								
$S_{gh,t}^{apt}$	0.720	0.473	0.595	0.395	1							
$S_{gh,t}^{ind}$	0.585	0.864	0.519	0.492	0.472	1						
$S_{gh,t}^{rtl}$	0.617	0.473	0.888	0.366	0.514	0.426	1					
$S_{gh,t}^{off}$	0.492	0.585	0.616	0.879	0.422	0.433	0.503	1				
$TSPR_t$	0.493	0.319	0.308	0.134	0.498	0.274	0.153	0.040	1			
$DSPR_t$	-0.284	-0.343	-0.278	-0.289	0.095	-0.104	-0.171	-0.356	0.286	1		
INF_t	-0.157	-0.102	-0.226	-0.208	-0.165	0.106	-0.024	-0.228	-0.092	0.172	1	
$TB3M_t$	-0.280	-0.131	-0.155	-0.211	-0.163	0.196	0.124	-0.090	-0.580	0.049	0.542	1

Table continued from previous page.

Table 2: Forecasting Regressions of Volatility of Excess Returns and Rent Growth for the Period 1986-2002

The table reports the results from the OLS regressions of the volatility of excess returns (Panel A) and rent growth (Panel B) at $t+1$ on economic variables and volatility at time t for apartments, industrial, retail, and office properties as they appear in equations (3) and (4) respectively. The table shows two specifications for each real estate property type: (1) includes only the economic variables, (2) includes also the lagged volatility. The economic variables are defined as in Table 1 and LAG is the time-t volatility. The t-ratios, in parentheses, are Newey-West with 4 lags. The R^2_{adj} goodness of fit measure and the p-value of an F test of joint null values are also displayed. The sample contains biannual observations from 1986:6 to 2002:12. The forecasting horizon is 1 semester.

Panel A: Volatility of Excess Returns

	Apartments		Industrial		Retail		Offices	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Constant	0.056	0.018	0.050	0.025	0.040	0.012	0.072	0.061
	(3.020)	(1.215)	(4.270)	(2.685)	(3.347)	(1.216)	(4.000)	(3.002)
$TSPR_t$	2.077	1.194	1.378	0.869	0.596	0.161	1.084	1.052
	(3.380)	(2.010)	(3.175)	(2.690)	(1.953)	(0.652)	(2.053)	(2.057)
$DSPR_t$	-5.036	-2.790	-4.171	-2.475	-1.578	-0.398	-3.904	-3.655
	(-2.566)	(-2.511)	(-2.711)	(-2.406)	(-1.183)	(-0.555)	(-1.978)	(-1.994)
CPI_t	-0.278	-0.159	0.052	0.131	-0.135	0.029	-0.570	-0.550
	(-0.893)	(-0.786)	(0.282)	(0.895)	(-0.751)	(0.310)	(-2.536)	(-2.689)
$TB3M_t$	0.589	0.466	0.349	0.202	0.160	0.019	0.438	0.469
	(1.687)	(2.049)	(1.283)	(0.995)	(0.655)	(0.138)	(1.203)	(1.386)
LAG	-	0.509	-	0.427	-	0.656	-	0.113
		(3.042)		(5.147)		(7.937)		(1.092)
R^2_{adj}	0.407	0.539	0.298	0.410	0.093	0.404	0.137	0.118
F	0.001	0.000	0.007	0.001	0.153	0.002	0.086	0.136

Table 2 (Cont'd): Forecasting Regressions of Volatility of Excess Returns and Rent Growth for the period 1986-2002

Panel B: Volatility of Rent Growth

	Apartments		Industrial		Retail		Offices	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Constant	0.028	0.020	0.007	0.001	0.019	0.003	0.058	0.039
	(2.537)	(1.451)	(0.703)	(0.112)	(1.507)	(0.383)	(6.081)	(3.513)
$TSPR_t$	0.873	0.661	1.173	0.672	0.590	0.205	0.740	0.665
	(2.273)	(1.706)	(3.707)	(2.782)	(2.101)	(1.028)	(1.947)	(1.821)
$DSPR_t$	-0.396	-0.448	-1.907	-1.018	-1.084	-0.229	-3.134	-2.564
	(-0.297	(-0.407)	(-1.975)	(-1.416)	(-0.762)	(-0.336)	(-1.855)	(-1.814)
CPI_t	-0.206	-0.136	0.049	0.133	-0.133	-0.010	-0.441	-0.368
	(-1.213)	(-0.864)	(0.366)	(1.031)	(-0.711)	(-0.081)	(-2.234)	(-2.108)
$TB3M_t$	0.291	0.241	0.582	0.280	0.363	0.125	0.405	0.389
	(1.002)	(0.942)	(2.944)	(1.983)	(1.580)	(1.107)	(1.455)	(1.594)
LAG	-	0.243	-	0.462	-	0.659	-	0.269
		(1.444)		(4.780)		(8.344)		(2.621)
R^2_{adj}	0.174	0.186	0.357	0.494	0.024	0.390	0.169	0.205
F	0.052	0.058	0.002	0.000	0.333	0.002	0.056	0.045

Table continued from previous page.

Table 3: Economic Significance of the Conditioning Variables

The table reports the marginal economic significance of the economic variables on the volatility of excess returns and rent growth. The table reports two entries: the first one corresponds to 2 times the standard error of the regressor times its coefficient, the second is the absolute value of the previous value divided by the average volatility, as it appears in Table 1. The table shows the results corresponding to the two specifications as in Table 2.

Volatility of Excess Returns

	Apartments		Industrial		Retail		Offices	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
$TSPR_t$	0.044	0.025	0.029	0.018	0.013	0.003	0.023	0.022
	0.629	0.361	0.508	0.321	0.312	0.084	0.368	0.358
$DSPR_t$	-0.025	-0.014	-0.020	-0.012	-0.008	-0.002	-0.019	-0.018
	0.353	0.196	0.357	0.212	0.191	0.048	0.307	0.288
INF_t	-0.008	-0.005	0.001	0.004	-0.004	0.001	-0.016	-0.016
	0.113	0.065	0.026	0.065	0.095	0.020	0.261	0.251
$TB3M_t$	0.020	0.016	0.012	0.007	0.005	0.001	0.015	0.016
	0.281	0.222	0.203	0.118	0.132	0.015	0.234	0.251

Volatility of Rent Growth

	Apartments		Industrial		Retail		Offices	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
$TSPR_t$	0.018	0.014	0.025	0.014	0.013	0.004	0.016	0.014
	0.380	0.288	0.589	0.337	0.362	0.126	0.308	0.277
$DSPR_t$	-0.002	-0.002	-0.009	-0.005	-0.005	-0.001	-0.015	-0.013
	0.040	0.045	0.222	0.118	0.154	0.033	0.303	0.248
INF_t	-0.006	-0.004	0.001	0.004	-0.004	0.000	-0.013	-0.011
	0.121	0.079	0.033	0.090	0.110	0.008	0.247	0.207
$TB3M_t$	0.010	0.008	0.019	0.009	0.012	0.004	0.014	0.013
	0.200	0.165	0.461	0.222	0.351	0.121	0.266	0.256

Table 4: Forecasting Regressions of Volatility of Excess Returns and Rent Growth for the period 1986-2002 with Dummy for Asymmetric Volatility

The table reports the results from the OLS regressions of the volatility of excess returns and rent growth at $t+1$ on economic variables, volatility at time t and the time-t value of a dummy variable that controls for asymmetric effects for apartments, industrial, retail, and office properties. The economic variables are defined as in Table 1, LAG is the time-t volatility and d_t is a dummy variable that takes value of 1 if the sum of the national average excess returns from period t to $t-2$ is higher than the time series average and zero otherwise. The t-ratios, in parentheses, are Newey-West with 4 lags. The R^2_{adj} goodness of fit measure and the p-value of an F test of joint null values are also displayed. The sample contains biannual observations from 1986:6 to 2002:12. The forecasting horizon is 1 semester.

	Volatility of Excess Returns				Volatility of Rent Growth			
	Apartments	Industrial	Retail	Offices	Apartments	Industrial	Retail	Offices
Constant	0.060	0.040	0.015	0.126	0.040	0.004	0.008	0.050
	(1.879)	(3.542)	(1.370)	(2.966)	(2.627)	(0.447)	(0.936)	(4.681)
$TSPR_t$	0.984	0.680	0.091	0.373	0.586	0.634	0.050	0.551
	(2.251)	(2.410)	(0.454)	(0.906)	(1.641)	(2.417)	(0.375)	(1.690)
$DSPR_t$	-4.513	-2.578	-0.347	-3.369	-1.534	-1.116	-0.338	-2.689
	(-2.618)	(-2.950)	(-0.477)	(-1.997)	(-1.259)	(-1.630)	(-0.499)	(-1.986)
INF_t	-0.047	0.135	0.021	-0.842	-0.080	0.138	-0.001	-0.483
	(-0.191)	(0.869)	(0.207)	(-3.049)	(-0.479)	(1.081)	(-0.007)	(-3.097)
$TB3M_t$	0.257	0.154	-0.010	0.008	0.284	0.303	0.188	0.441
	(1.289)	(0.878)	(-0.084)	(0.020)	(1.032)	(2.159)	(1.763)	(2.049)
LAG	0.435	0.422	0.707	0.049	0.136	0.458	0.768	0.238
	(2.390)	(4.948)	(7.663)	(0.381)	(0.639)	(4.737)	(6.855)	(2.740)
d_t	-0.016	-0.011	-0.004	-0.028	-0.010	-0.003	-0.010	-0.009
	(-2.030)	(-2.443)	(-1.155)	(-2.181)	(-2.128)	(-0.602)	(-2.347)	(-2.531)
R^2_{adj}	0.575	0.440	0.405	0.288	0.198	0.480	0.416	0.223
F	0.000	0.001	0.003	0.018	0.064	0.001	0.002	0.046

Table 5: Forecasting Regressions of Absolute Dispersion in Excess Returns and Rent Growth for the Period 1986-2002

The table reports the results from the OLS regressions of the measure of absolute dispersion (as defined in equations (7) and (8)) of excess returns (Panel A) and rent growth (Panel B) at $t+1$ on economic variables and volatility at time t for apartments, industrial, retail, and office properties. The table shows the specification with the lagged value of the forecasted variable. The macroeconomic variables are defined as in Table 1 and LAG is the time-t volatility. The t-ratios, in parentheses, are Newey-West with 4 lags. The R^2_{adj} goodness of fit measure and the p-value of an F test of joint null values are also displayed. The sample contains biannual observations from 1986:6 to 2002:12. The forecasting horizon is 1 semester.

	Volatility of Excess Returns				Volatility of Rent Growth			
	Apartments	Industrial	Retail	Offices	Apartments	Industrial	Retail	Offices
Constant	0.111	0.131	0.049	0.157	0.154	0.044	0.023	0.110
	(2.466)	(5.006)	(1.714)	(3.733)	(3.343)	(1.998)	(0.973)	(3.218)
$TSPR_t$	1.898	1.673	0.061	1.566	1.776	1.397	0.541	1.207
	(2.109)	(2.155)	(0.095)	(1.760)	(2.445)	(2.179)	(0.978)	(1.367)
$DSPR_t$	-5.614	-5.659	0.064	-4.605	-2.089	-2.278	-0.298	-3.243
	(-2.807)	(-2.210)	(0.039)	(-1.625)	(-0.880)	(-1.144)	(-0.228)	(-1.182)
INF_t	-0.214	0.248	0.252	-0.784	-0.500	0.162	0.013	-0.518
	(-0.576)	(0.716)	(1.090)	(-2.359)	(-1.571)	(0.443)	(0.037)	(-1.317)
$TB3M_t$	0.784	0.398	-0.138	0.911	0.804	0.681	0.279	0.754
	(1.982)	(0.846)	(-0.379)	(1.574)	(1.598)	(1.753)	(0.815)	(1.379)
LAG	0.509	0.412	0.739	0.300	0.130	0.560	0.747	0.422
	(3.389)	(5.256)	(10.694)	(2.596)	(0.828)	(5.644)	(9.969)	(4.217)
R^2_{adj}	0.557	0.382	0.452	0.150	0.184	0.550	0.548	0.212
F	0.000	0.002	0.001	0.093	0.060	0.000	0.000	0.041

Table 6: Forecasting Regressions of Absolute Dispersion in Excess Returns and Rent Growth for the Period 1986-2002 with Dummy for Asymmetric Effect

The table reports the results from the OLS regressions of the measure of absolute dispersion (as defined in equations (7) and (8)) of excess returns (Panel A) and rent growth (Panel B) at $t+1$ on economic variables, absolute dispersion at time t and the time t value of a dummy variable that controls for asymmetric effects for apartments, industrial, retail, and office properties. The economic variables are defined as in Table 1, LAG is the time-t absolute dispersion and d_t is a dummy variable that takes value of 1 if the sum of the national average excess returns from period t to $t-2$ is higher than the time series average and zero otherwise. The t-ratios, in parentheses, are Newey-West with 4 lags. The R^2_{adj} goodness of fit measure and the p-value of an F test of joint null values are also displayed. The sample contains biannual observations from 1986:6 to 2002:12. The forecasting horizon is 1 semester.

	Volatility of Excess Returns				Volatility of Rent Growth			
	Apartments	Industrial	Retail	Offices	Apartments	Industrial	Retail	Offices
Constant	0.186	0.165	0.055	0.254	0.195	0.053	0.029	0.140
	(2.419)	(6.024)	(1.681)	(3.731)	(3.712)	(2.227)	(1.215)	(3.611)
$TSPR_t$	1.521	1.305	-0.116	0.719	1.615	1.265	0.177	0.945
	(2.278)	(1.950)	(-0.221)	(1.112)	(2.484)	(1.955)	(0.420)	(1.245)
$DSPR_t$	-8.327	-5.933	0.111	-4.284	-3.947	-2.540	-0.529	-3.531
	(-3.139)	(-2.642)	(0.067)	(-1.529)	(-1.427)	(-1.339)	(-0.447)	(-1.310)
INF_t	-0.049	0.255	0.238	-1.186	-0.407	0.180	0.042	-0.803
	(-0.113)	(0.706)	(0.888)	(-2.896)	(-1.276)	(0.509)	(0.120)	(-2.488)
$TB3M_t$	0.455	0.303	-0.214	0.321	0.881	0.740	0.409	0.900
	(1.290)	(0.750)	(-0.640)	(0.539)	(1.618)	(1.944)	(1.234)	(2.013)
LAG	0.446	0.400	0.781	0.224	0.059	0.561	0.816	0.392
	(2.595)	(5.085)	(9.610)	(1.668)	(0.319)	(5.340)	(8.795)	(3.844)
d_t	-0.025	-0.022	-0.010	-0.037	-0.017	-0.009	-0.022	-0.021
	(-2.211)	(-2.291)	(-1.118)	(-2.420)	(-1.490)	(-0.746)	(-2.390)	(-3.273)
R^2_{adj}	0.595	0.408	0.455	0.254	0.182	0.540	0.562	0.248
F	0.000	0.002	0.001	0.030	0.077	0.000	0.000	0.033

Table 7: Forecasting Regressions of Volatility in Excess Returns and Rent Growth for the period 1994-2003

The table reports the results from the OLS regressions of the volatility of excess returns and rent growth at $t+2$ on economic variables and volatility at time t for apartments, industrial, retail, and office properties. The economic variables are defined as in Table 1 and LAG is the time-t volatility. The t-ratios, in parentheses, are Newey-West with 4 lags. The R^2_{adj} goodness of fit measure and the p-value of an F test of joint null values are also displayed. The sample contains quarterly observations from 1994:6 to 2003:3. The forecasting horizon is 2 quarters.

	Volatility of Excess Returns				Volatility of Rent Growth			
	Apartments	Industrial	Retail	Offices	Apartments	Industrial	Retail	Offices
Constant	0.079	0.049	0.039	0.166	0.083	-0.002	-0.040	0.141
	(3.167)	(1.328)	(1.001)	(2.563)	(4.346)	(-0.024)	(-1.672)	(2.084)
$TSPR_t$	0.503	-0.191	0.026	-0.687	-0.068	0.223	0.663	-0.398
	(1.243)	(-0.525)	(0.063)	(-1.363)	(-0.346)	(0.519)	(2.483)	(-0.538)
$DSPR_t$	-5.624	-2.445	-2.394	-7.877	-4.283	-0.739	0.824	-7.320
	(-3.347)	(-1.273)	(-1.435)	(-2.202)	(-4.992)	(-0.220)	(0.675)	(-2.190)
INF_t	0.027	-0.020	0.121	-0.064	0.106	0.049	0.037	-0.098
	(0.306)	(-0.180)	(2.117)	(-0.455)	(1.215)	(0.491)	(0.480)	(-0.741)
$TB3M_t$	0.112	0.246	0.017	-0.954	-0.316	0.771	0.815	-0.700
	(0.307)	(0.497)	(0.041)	(-1.463)	(-1.432)	(1.069)	(2.830)	(-0.843)
LAG	0.099	0.222	0.242	-0.011	0.059	0.151	0.529	0.006
	(0.658)	(2.148)	(1.142)	(-0.104)	(0.620)	(1.126)	(4.836)	(0.073)
R^2_{adj}	0.555	0.484	0.364	0.147	0.309	0.399	0.597	0.105
F	0.000	0.000	0.003	0.096	0.009	0.002	0.000	0.157

Table 8: Risk-Return Regression

The table reports the results from the OLS regressions of the mean excess returns at $t+1$ on the $t+1$ returns of the $S\&P500$ (denoted by R^M_{t+1}), lagged cross-sectional variance of excess returns ($S^2_{r,t}$) and lagged term spread ($TSPR_t$) for apartments, industrial , retail and office properties. The table shows two specification: (1) uses the $S\&P500$ returns and the lagged variance of excess returns as regressors, (2) adds the lagged default spread. The t-ratios, in parentheses, are Newey-West with 4 lags. The R^2 goodness of fit measure and the p-value of an F test of joint null values are also displayed. The sample contains biannual observations from 1986:6 to 2002:12. The forecasting horizon is 1 semester.

	(1)				(2)			
	Apartments	Industrial	Retail	Offices	Apartments	Industrial	Retail	Offices
constant	0.046	0.048	0.021	0.020	0.158	0.108	0.079	0.117
	(2.900)	(3.463)	(1.239)	(1.277)	(8.181)	(3.555)	(3.089)	(3.023)
R^M_{t+1}	0.027	0.033	-0.004	0.043	0.019	0.030	-0.008	0.032
	(0.925)	(1.346)	(-0.129)	(1.361)	(0.978)	(1.487)	(-0.239)	(1.161)
$S^2_{r,t}$	4.158	1.996	16.493	3.769	2.931	0.751	14.218	2.453
	(2.963)	(1.000)	(2.967)	(2.469)	(3.051)	(0.410)	(3.012)	(1.680)
$DSPR_t$	-	-	-	-	-12.052	-6.303	-6.229	-10.331
					(-5.102)	(-1.604)	(-2.129)	(-2.325)
R^2	0.178	0.065	0.194	0.119	0.534	0.214	0.332	0.339
F	0.058	0.378	0.044	0.158	0.000	0.076	0.009	0.008

Figure 1: Time Series of $S_{r,t}$ and $S_{gh,t}$

The figure reports the time series plot of the volatility of excess returns (solid line) and volatility of rent growth (dashed line), as defined in equations (1) and (2), for all four property types during the 1986:6 - 2002:12 period.