NBER WORKING PAPER SERIES

EVIDENCE ON RATIONALITY IN COMMERCIAL PROPERTY MARKETS: AN INTERPRETATION AND CRITIQUE

Patric H. Hendershott
Robert J. Hendershott
Bryan D. MacGregor

Working Paper 11329
http://www.nber.org/papers/w11329

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
May 2005

Presented at the 2004 AREUEA Annual Meetings. We thank Dennis Capozza and Charles Ward for discussions of this issue and comments on an early draft of the paper. The views expressed herein are those of the author(s) and do not necessarily reflect the views of the National Bureau of Economic Research.

Evidence on Rationality in Commercial Property Markets: An Interpretation and Critique
Patric H. Handershott, Robert J. Hendershott, and Bryan D. MacGregor
NBER Working Paper No. 11329
May 2005
JEL No. G0

ABSTRACT

Periodic sharp sustained increases and then reversals in asset prices lead many to posit irrational price bubbles. The general case for irrationality is that real asset prices simply have moved too much given the future real cash flows the assets are reasonably likely to produce. A corollary for property is that observed mean reversion in real cash flows is not reflected in investor valuations, resulting in asset values being too high when real cash flows are high and vice versa. In this paper we interpret, critique and extend existing analyses of movements in real commercial property prices during the late 1980s and early 1990s.

Patric H. Hendershott
Aberdeen University Business School
Old Aberdeen Scotland AB9 2UF
United Kingdom
and NBER
phh3939@arvig.net

Robert J. Hendershott
Finance Department
Leavey School of Business
Santa Clara University
Santa Clara, CA 95053
r.hendershott@scu.edu

Bryan D. MacGregor
Aberdeen University Business School
Old Aberdeen Scotland AB9 2UF
United Kingdom
b.d.macgregor@abdn.ac.uk

Evidence on Rationality in Commercial Property Markets: An Interpretation and Critique

Sharp price reversals in commercial property values during the early 1990s have raised questions regarding the rationality of property markets. Real office values in the OECD countries fell by an average of 55 percent between the late 1980s/early 1990s peak and the trough after nearly doubling between 1985 and the peak (Hendershott, Hendershott and Ward, 2003). The boom in technology and internet stocks in the late 1990s and subsequent reversal raised even greater concerns regarding the rationality of stock markets (Shiller, 2000). That is, many argue that asset bubbles – sharp, temporary price increases that cannot be plausibly explained by changes in fundamental value drivers – have occurred.

A number of alternatives to blind irrationality can explain property price spikes. First, expected rates of growth in real cash flows and real discount rates may move abruptly, causing fundamental values to change similarly. Moreover, high transactions costs and long construction periods could prevent rapid supply responses to gaps between fundamental value and replacement cost, rationalizing high market values (transactions costs are generally far higher and production periods far longer for direct property than for stocks). That is, sharp real property price cycles may in fact be fully rational.

Second, principal-agent problems could cause agents rationally to bid prices significantly above fundamental value. To illustrate, large scale investments are typically undertaken by financial institutions where those making the investment decisions are not those whose money is being invested. Because the agents making the investments are rewarded on short-term relative performance and feel they are unable to predict the *timing* (rather than incidence) of a price reversal (Schifler and Vishney, 1998), agents may continue buying (or at least may not sell) even when they believe that market prices are above their 'fundamental' values. If agents sell too soon and the market keeps rising, they will incur negative relative performance. On the other hand, if they are still in the market along with competitors when it collapses, there will be no differential performance. Keeping an eye on competitors means that once the market begins to turn, everyone wants out and collapse become self-fulfilling (Ball, Lizieri and MacGregor, 1998).

Third, minor degrees of irrationality, what is often called "bounded rationality", may exist. While economic theory provides limited guidance about what particular elements of irrationality exist among investors, a number of papers show that limited deviations from full rationality can lead prices to deviate from fundamental values in predictable ways. Barberis, Shleifer, and Vishny (1998) focus on investor conservatism – the reluctance to update beliefs in the face of new information – and Daniel, Hirshleifer and Subrahmanyam (1998) focus on overconfidence – the tendency to overestimate the quality of one's own information – as particular cognitive biases that can affect asset prices. Scheinkman and Xiong (2003) show how overconfidence combined with short-sale constraints can lead to asset bubbles. Hong and Stein (1999) argue that when information diffuses slowly, simple momentum strategies are profitable on average, which cause prices to overshoot fundamental values. That is, not only can investors' cognitive biases lead to bubbles, interactions between unbiased, but limited perspective, agents can lead to bubbles.

In this paper we examine, interpret, and critique studies of rationality in commercial property markets. These studies can be divided into three groups.[1] First, there are a number of comparisons of movements in real property prices and real cash flows that question whether the cash flow movements can reasonably justify the asset price shifts. Such studies include Bjorklund and Soderberg (1999), Hendershott (1996 and 2000) and Quigley (1999) and cover the Swedish, Australian and Asian property markets, respectively. All conclude that the ratios of value to cash flow were too high at the cyclical peak, i.e., that bubbles occurred.

[1] While a substantial, growing literature on housing bubbles exists, the owner-occupant nature of this market makes analysis of it fundamentally different from markets for purely investment assets. More specifically, the purchase of another bond or stock has no impact on the cash flow rate of return on existing holdings. In contrast the purchase of a second house substantially lowers the cash flow (implicit rent) rate of return one receives from the original house, which is no longer occupied year around. Similarly, there are obviously large declines in cash flow rates of return from owners occupying larger and larger residences.

Second are empirical analyses of capitalization rates, the key test being whether cap rates have been positively related to deviations between actual and trend real cash flows. Because real cash flows are clearly and necessarily trend reverting, actual cash flows above trend imply slower future real cash flow growth and thus higher cap rates. Using NCREIF data, both Sivitanides *et. al.* (2001) and Hendershott and MacGregor (2005b) contend that US investors behaved irrationally because capitalization rates were lower (value/NOI ratios higher) the further real cash flows were above trend. In contrast, Hendershott and MacGregor (2005a) provide evidence of rational expectations of mean reversion in UK office and retail markets.

Third, variance bounds tests of actual and fundamental values and tests of the cointegration of real values and real cash flows have been borrowed from the finance literature. Scott (1990) and Brooks *et. al.* (2001) apply the variance bounds tests to US REIT and UK property company share price data, respectively. Lui and Mei (1994) and Wang (2000) report cointegration tests using US REIT and UK property share prices, respectively. The variance bounds tests provide strong evidence of property bubbles, while the cointegration tests rebuke the existence of bubbles. However, neither type of test seems very convincing.

This paper is divided into five sections and a conclusion. We begin with a general discussion of market pricing in asset markets and problems peculiar to the valuation of direct or nonsecuritized commercial real estate. Next we discuss fundamental value and some claims that it has significantly deviated from the market value of commercial property in Asia, Australia and Sweden. In Section III we turn to tests of rationality based on empirical analyses of capitalization rates in the US and the UK. Section IV reviews Hall's analysis (2001) of the rationality of US equity valuation and applies Hall-type tests to capitalization rate data from the UK office and retail property markets. Section V considers the formal finance related tests, questioning the assumptions underlying variance bounds tests of rationality in securitized property markets and the value of cointegration tests for bubbles. Section VI concludes.

I. Market Pricing

The standard model of market prices has fully rational individuals buying (selling) when market prices fall below (rise above) their fundamental value estimates (see, for example, Shleifer and Summers, 1990). Savvy investors recognize that their estimates contain errors, which makes them unwilling to buy/sell large amounts of the asset unless prices deviate significantly from what they perceive to be true value. How much an investor is willing to commit beyond a particular asset position depends on their degree of risk-aversion and wealth (and ability to borrow), as well as the size of their current asset position. Investors' flow demand (supply) schedules – how much an investor will buy/sell at a particular price – will create an increasing demand for an asset as its price falls and increased selling as the asset price rises. Consequently, prices should be fairly stable in the absence of new information – as price rises in response to an influx of buyers, the asset becomes less attractive to existing holders (both because of the higher price and the higher value of their holdings), creating willing sellers that limit the price increase.

The standard model encompasses investors disagreeing about fundamental values – when investors have different opinions, the market price will reflect their willingness and ability to trade. Essentially, investors vote their beliefs based on their capital. If most investors believe an asset is undervalued, their willingness (eagerness) to buy causes the price to rise. Investors who are generally correct about when assets are over/undervalued tend to make money, creating a feedback mechanism that improves price setting over time (better investors accumulate more capital, garnering more "votes"). This model would seem to rule out asset bubbles as well as the observed tendency for asset real prices and returns to be autocorrelated over short time horizons (Jegadeesh and Titman, 1993) and mean reverting over long horizons (Jegadeesh and Titman, 2001).

But Hong and Stein (1999) show that slight modifications to the standard model can generate the autocorrelation and reversion characteristics observed. Hong and Stein partition investors into two groups: "newswatchers" and "momentum traders":

> Neither type is fully rational in the usual sense. Rather, each is boundedly rational, with the bounded rationality being of a simple form: each type of agent is only able to "process" some subset of the available public information. The newswatchers make forecasts based on signals that they privately observe about future fundamentals; their limitation is that they do not condition on current or past prices. Momentum traders, in contrast, do condition on past price changes. However, their limitation is that their forecasts must be "simple" (i.e., univariate) functions of the history of past prices. (pp. 2144-45).

Because private information diffuses gradually across the newswatcher population, prices adjust slowly to new information (there is autocorrelation or momentum in asset real prices and returns). Because momentum traders use simple strategies, the momentum in real prices is magnified, causing them to overshoot (momentum traders tend to make money early in the cycle and lose it late when the "bubble" bursts). That is, real prices eventually revert to their fundamental values.[2]

In any market high selling costs and/or difficulties in selling short will limit the ability of those inclined to sell (and, where possible, short sell).[3] Selling costs include taxes on sales value ("stamp duties") and on capital gains, the recapture of tax depreciation, and brokerage fees. These costs – which tend to be substantially higher for commercial real estate than stocks – would allow prices to exceed fundamental value by large percentages without enticing holders to sell or others to try to short. Moreover, the possibility that the market is on the leading edge of a momentum-driven price surge discourages selling (and especially shorting) even by investors whose market value exceeds their perceived value (see, for example, Brunnermeier and Nagel, 2004).

On the other hand, easy production of additional substitutable assets would inhibit large deviations of price from fundamental value. For example, the issuance of new corporate shares (IPOs and secondary offerings) in booming markets should limit stock market bubbles. Ofek and Richardson (2003) establish a cross section relation between new share availability and price declines – individual internet

[2] Capozza, Hendershott and Mack (2004) present results explaining real house prices for a panel of US cities that are consistent with this model. On an annual basis, real house prices adjust only about 50 percent to changes in fundamental values, and real prices exhibit strong serial correlation and mean reversion. At the mean values of autocorrelation and mean reversion, actual prices overshoot fundamental prices by 20 percent, but with autocorrelation a standard deviation above the mean and mean reversion a standard deviation below, 70 percent overshooting occurs.

[3] Ofek and Richardson (2003) document the unusually high costs of shorting internet stocks during the late 1990s.

stocks underperform a broad internet index by as much as 33% over six-month periods in which new shares become available – and hypothesize that the creation of new shares played a crucial role in ending the internet stock market bubble. However, constraints on efforts to create additional properties when value exceeds replacement cost (e.g., planning restrictions and limited land supply) might permit large price-value gaps in commercial real estate.

The role of new supply in controlling the gap between price and fundamental value is illustrated in Figure 1. The two lines are an index of dot.com stocks (scaled to unity at the end of 1996) and the number of internet IPOs by month over the 1997-2001 period (the data in Figure 1 are discussed in Hendershott, Hendershott and Ward, 2003). Both the large stock price gains and the sharp plunge that followed are clear. Prices rose more than 400 percent annually from May 1997 to April 1999 (they were up nine-fold by late 1998), oscillated for eight months, and fell almost 85 percent during 2000. Internet IPOs moved similarly. After never reaching double digits during 1997 and 1998, internet IPOs jumped in early 1999 and averaged 31 per month between May 1999 and March 2000 (typically 30 to 40 IPOs are issued monthly in *all* industries). These issues likely stressed the financial resources of buyers of internet stocks and contributed to the price reversal.

Gentry and Mayer (2003) provide another example of security supply responding to gaps between price and fundamental asset value. Their Figure 3 plots both the ratio of share prices to estimates of the (appraised) net asset value of REIT real assets and the dollar volumes of REIT share issues and repurchases. While the 1992-95 data do not strongly reveal the expected pattern, the 1996-2000 data certainly do. When REITs were 10 to 25 percent "over-priced" in 1996-97, share issues doubled from the 1992-95 average. When the price/value ratio slipped to 1.05 in 1998, issues plummeted and repurchases rose. And when the ratio fell below unity in 1999-2000, repurchases far exceeded issues.

The stock of commercial properties also responds to differences between real property values and their replacement cost. But the lengthy lag in bringing new product to market, especially for large developments, extends the period in which excess real cash flows will be earned and thus rationalizes higher prices. Further, development is often funded with lines of credit where developers put their equity into the project before credit is made available. This creates an option-like position that virtually guarantees eventual completion of developments once a loan is negotiated and the property developer has spent his contribution. Even if the underlying economics of the property market sour, the developer has little incentive to curtail construction because any additional loss will accrue totally to the lender. Thus, the creation of new assets in a property boom may continue well after the boom ends, driving value far below replacement cost. In contrast, hundreds of planned initial public offerings were "pulled" after the stock market reversal in 2000 and 2001. Moreover, there is no equivalent to REIT repurchases and little scope (at least in the short term) to reduce the supply of a particular real property type.[4]

II. Some Estimates of Fundamental Value and Claims of Investor Irrationality

The fundamental value, *FV*, of an asset is the present value of future cash flows expected by marginal investors.[5] For properties,

$$FV = \sum_{t=1}^{\infty} \frac{(1-v_t)R_t}{\prod_{i=1}^{t}(1+i_i)...(1+i_t)} \tag{1}$$

where *R* is net rent (for simplicity we assume triple net leases so tenants pay all expenses), *v* is the vacancy rate, and *i* is the discount rate. If rent is in real terms, then *i* is the real discount rate; if rent is nominal, *i* is the nominal discount rate. For securitized real estate, the numerator is replaced by expected real cash flow payouts, *CFs*. Utilizing (1) to obtain fundamental value estimates is no simply task. In effect, processes driving expectations of *R, v*, and *i* need to be specified.

Regarding the cash flow process, both corporate (dividends) and property (net rents) real cash flows are simultaneously autocorrelated and mean or trend reverting. Positive autocorrelation means that

[4] In the medium term, properties in excess supply could be converted to alternative uses. To illustrate, some offices were converted to apartments in London following the 1989-90 crash in office values.

when real cash flows are rising, they tend to continue to rise in the short term and vice-versa. For example, if there is a positive demand shock, the shortage of space will compound as existing leases rollover until newly-developed properties begin opening. Mean or trend reversion means that in the longer term cash flows are pulled toward an equilibrium level. That is, after real rents rise (fall) in response to a positive (negative) shock, the rolling over of existing leases and new development (absorption) will eventually drive real rents back to their equilibrium level.[6]

Wheaton and Torto (1994) provide evidence on mean reversion in real US cash flows. Hendershott (1996) and Hendershott and MacGregor (2005a) present similar evidence on real office market rents in Sydney and London; real rents doubled in London and tripled in Sydney during the second half of the 1980s and fell by two-thirds in the early 1990s.

Hendershott (1996 and 2000) computed fundamental value for the Sydney office market during the turbulent 1985-95 period. He specified equilibrium real rent based on a user cost of capital calculation and estimated a real rental adjustment equation that provided a long-run equilibrium vacancy rate as well as an equation for forecasting real rents from lagged gaps between equilibrium and actual real rents and vacancy rates. The key to the study was the availability of confidential data on forecasts of vacancy rates during the crucial 1989-92 years. Hendershott constructed rolling future expected real cash flows from the vacancy rate forecasts and the rent forecasting equation and then computed a fundamental value series from equation (1). He found the observed surge and reversal of real Sydney office values in the late 1980s and early 1990s to be grossly inconsistent with this fundamental value series. In effect, market value rose to twice fundamental value before reversing.

---

[5] This is, of course, a simplification. To the extent that the asset contains options for the owner, the values of these must be added.

[6] The argument regarding real corporate dividends is similar (Shiller, 1981, and Barsky and DeLong, 1992). Price-earnings ratios (P/E) – and, consequently, earnings yields (E/P) – are determined by market opportunities, growth and profit margin. A high P/E (low E/P) signifies that these firms enjoy relatively high margins and/or growth opportunities. However, these will attract competition, reducing incumbent firms' profit margins and future growth opportunities and thus P/E ratios. Because of lags between positive shocks and new corporate competitors entering a market, real earnings, as well as real rents, are positively auto-correlated in the short-term, mean reverting (negatively correlated) in the long-term, and cyclical.

While numerous assumptions underlay Hendershott's computations (including the constancy of real interest rates) and thus create uncertainty regarding their precision, the basic mispricing in Sydney is evident in Figure 2, where real office rents and the BOMA value/rent ratio are plotted. Both are scaled to 20 in 1985, when the market was in reasonable balance (real rents had doubled from the trough in 1977 and the vacancy rate equaled 2.6 percent, down from 12 percent in 1978). A further 40 percent rise in real rents through 1989 was associated with a more than 40 percent rise in value as the value/rent ratio rose. This is inconsistent with rationality. With expected mean reversion in real rents, the value/rent ratio should have fallen as the rent peak approached, rather than continued to rise after the peak. The extended, smoothed downward-sloped dashed line in the figure would be consistent with rational pricing. This simple analysis supports Hendershott's calculations. The value/rent ratio in 1990 should have been about half of that observed; market value was about double fundamental value.

Bjorklund and Soderberg (1999) and Quigley (1999) made comparable observations about value/rent ratios in Swedish and Asian real estate markets, respectively. Bjorklund and Soderberg examined the 1985-94 cycle in Swedish property and concluded that the ratio of property values to rents increased too much in the late 1980s. While real rent and real price increased equally between 1983 and 1986, roughly doubling, real rents increased by only 24 percent more through 1990, far less than the 144 percent surge in real price. Quigley argued that value/rent ratios were far out of line for offices in Kong Kong and Singapore, for retail in Hong Kong, and for condominiums in Jakarta in the middle 1990s. Especially telling is that these extraordinarily high ratios existed in the face of forecasted large increases in supply and vacancies, which certainly should have predicted large declines in real cash flows.

III. Mean Reversion and Capitalization Rates: Contrasting Evidence from the US and the UK

If cash flow is expected to grow at a constant rate g forever and the discount rate is expected to be constant for all time at i, then equation (1) reduces to the Gordon growth model:

$$FV = \frac{CF}{i - g} . \tag{2}$$

where CF is the next period cash flow. This equation holds whether *i* and *g* are both defined as real rates or as nominal rates (in what follows we interpret them as real rates). The ratio of this cash flow to price or value, the "cap" rate, is just the difference between the discount rate and the growth rate. And the "price/earnings" ratio (the ratio of value to cash flow) is just the inverse of the cap rate.

If investors understand that real cash flows are mean reverting, they will expect high growth when real cash flow is low and low growth when real cash flow is high, i.e., *g* is a negative function of the ratio of real *CF* to its mean *CFMean* and

$$cap = i - g\left(\frac{\overline{CF}}{CFMean}\right) . \tag{3}$$

With growth depending negatively on the ratio, the cap rate should vary positively with the ratio. That is, to compensate for the expected reversion in real cash flows, investors should apply relatively high cap rates to high real cash flows and relatively low cap rates to low real cash flows. Thus, investigations of capitalization rates provide evidence on expected mean reversion and investor rationality generally.

Sivitanides *et.al.* (2001) investigated the log of annual office capitalization rates from the NCREIF data base in 14 U.S. metropolitan areas during the 1984-2000 period. The primary economic determinants of the cap rate were two real rent series, the ratio of real rent to its average over the 1980-99 period (to capture mean reversion) and the annual growth rate in real rent (to capture autocorrelation). However, the real rent ratio had a negative coefficient, suggesting that when real rents were high, investors expected them to go higher and thus they capitalized current rent with a lower than normal cap rate (unreported results for other property types were similar). This is, of course, the opposite of what investors should do if they expect real rents to revert to the mean. Wheaton *et. al.* (2001, pp. 26-27) summarize the argument for inefficient property markets.

Actually, this evidence on inefficiency is weaker than it appears because the rent ratio is lagged two years. (If property cycles were four years in duration, two up and two down, rationality would *imply* a negative relation between current capitalization rates and the ratio of real rents two years ago to the mean.) It is a negative relation between cap rates and the *current* rent ratio that would be especially troubling. Using comparable data, Chen, Hudson-Wilson and Nordby (2004) show that the negative relationship does hold concurrently.[7] However, they interpret the ratio of current to mean real rent as a determinant of the risk premium required on real estate, not of the expected real cash flow growth rate. They argue that lower premiums are required in "hot" markets and thus that the negative coefficient on the ratio is consistent with rationality. We find it most implausible that a lower risk premium would rationally be required the greater is the downside risk to real cash flows (was it rational to assume that equities were less risky at their peak in early 2000 than earlier?), much less that the premium impact would be greater than the positive impact on the cap rate through a lower expected real growth rate.

Hendershott and MacGregor (2005b) have taken another look at the NCREIF data. In spite of using supposedly better capitalization rates (deleting those based on stale appraisals) and analyzing supposedly better panels of data and deleting early observations (both adjustments being designed to reduce NOI growth outliers), they found the same negative relationship held between capitalization rates and the ratio of real NOI to its trend value. Based on the NCREIF real cash flow data, US investors appear to have behaved irrationally in that they have not factored expectations of mean reversion of real cash flows into their asset pricing as reflected in capitalization rates (using Torto-Wheaton market rent data gives the same result).[8] In fact, investors appear to have been willing to pay more for a dollar of real

---

[7] They analyze an office panel of 14 MSAs, 13 of which are similar to those of Sitivanides *et. al.* (2001); they use data from the 1982-02 period.

[8] Proxies for the log deviation of real NOI from its trend value are, in fact, reasonable correlates of the observed growth in real cash flow over the next five years. We investigate the validity of the proxies by correlating actual real NOI growth over the next five years with two measures of the divergence of real NOIs from trend values: the log deviation of real NOI from its tread value and the ratio of TW real rent to mean TW real rent. The correlations for the 1986.1-1998.1 period are negative: the more positive is the deviation or the ratio, the lower is future growth. The average correlation coefficient for the property types (average of six MSAs for offices and retail and ten for industrial) are -0.71 for offices and about -0.6 for retail and industrial.

cash flow when that flow was rationally expected to erode in the future than they would pay when the flow was rationally expected to increase.

The problem implicit in these data is illustrated in Figures 3 and 4, where we have plotted NCREIF capitalization rates in Southern California against the deviations of real NOI from trend for both industrial and office properties. Rationality suggests a positive relation. That is, the further real NOI is above trend, the less rapidly we should expect it to grow and thus the less we should be willing to pay for a dollar of it (the higher should capitalization rates be). The relation is consistently negative, not positive, for both the office and industrial markets. Similar relationships exist for numerous other US regions.

In contrast to the analysis of US NCREIF data, evidence from the UK office and retail markets suggests that UK investors did build mean or trend reversion into their valuations. Hendershott and MacGregor (2005a) relate cap rates to both the recent growth in real rents and the deviation of current real rent from its trend value. Here the deviation enters positively, implying that when real rents were high investors expected them to fall and thus applied a high capitalization rate to the temporarily high current rent. This holds for both office and retail valuations. The capitalization and rent series are for hypothetical new buildings newly let at market rents and are thus not confounded by the problems of existing lease structures, headline rents diverging from effective rents, etc.

Data for UK real office rents and value/rent ratios are plotted in Figures 5 and 6. Contrast these with the similar graph for Sydney (Figure 2), where the office value/rent ratio rose rapidly with real rents and did not reverse itself until after real rents began to collapse. In the UK, the ratios did not rise as sharply as real rents rose and turned down before real rents did, as we would expect to be the case in rational markets.

Hendershott and MacGregor (2005a) illustrate the success of their estimation by showing the correspondence of their dynamically simulated cap rate with the actual cap rate. In the dynamic simulation the lagged cap rate that feeds into the adjustment equation is the cap rate simulated from the previous period, rather than the actual previous period cap rate. They then convert the simulated cap rates into real values by dividing them into real market rents. Their model explains virtually all of the 1985-89 increases in office and retail real values and the entire subsequent decline. That is, there is little cyclical value change to attribute to irrationality. At least for the UK, the late 1980s-early 1990s boom and bust is captured with a rational model.

IV. Applying Hall's US Stock Market Tests to UK Property Prices

Hall (2001) provides some innovative tests of rationality of the aggregate US stock market during the last decade based upon the inverse of the cap rate, the price/earnings ratio. Hall performs two calculations of variants of equation (3). In this section we discuss his methodology and apply it to the UK property market.

In one calculation, Hall computes the *nominal* cash flow growth rate implied by the financial markets and compares it to the 5-year forward growth rate in nominal (not real) cash flows. With *cap* equaling $i - g$ and i being the sum of the default-free rate d and a risk premium *prem*, the growth rate implied by the financial markets is $g = d + prem - cap$. Hall uses the 10-year Treasury rate for d, sets *prem* at 0.082 (the value that equates $d+prem$ to the average ex post nominal return on US stocks over the period), and computes *cap* as the ratio of the value of corporate securities to corporate cash flow (after-tax profits plus interest payments). He then solves for his "financial market" g and compares it to actual five-year future nominal growth. The closeness of the two series is a joint test of three hypotheses: if the risk premium has been constant, if five-year future nominal growth approximates expected future nominal growth, and if the stock market were rationale, then these two series should be closely correlated.

Comparison of this nominal financial market g and the 5-year forward nominal growth rate in cash flows (Hall's Figure 9) reveals a positive relationship, although the correlation is loose to put it gently. Actual growth far exceeded forecasted growth during most of the 1970s, when inflation was accelerating, and was far less during most of the 1980s, when inflation was slowing.[9] One could reasonably argue that the loose association of the two series is an indication of investors' inability to

[9] Hall notes that the actual nominal forward growth rate is more volatile than the financial market growth rate, as Shiller (1981) suggested should be the case in an efficient market.

predict changes in inflation (expected nominal earnings growth was less than ex post growth in the 1970s and greater in the 1980s), not evidence of irrational pricing.

In his second calculation, Hall inverts the cap rate ratio to obtain the capitalization factor (price/earnings ratio) with which investors multiply current corporate cash flow to obtain the value of securities. He then compares this factor or multiplier with the 5-year forward growth rate in *real* corporate cash flow (i and g are now real rates). The expected relationship is positive, although nonlinear; with the multiplier equaling $1/(i\text{-}g)$ and $i = 0.10$, a rise in g from –0.05 to 0 to +0.05 would increase the multiplier from 6.7 to 10 to 20. That is, if real interest rates were constant, if ex post five-year future real cash flow growth approximated ex ante expected future growth, and if the stock market were rationale, these two series should be positively (but nonlinearly) correlated. As Hall's Figure 7 shows, the actual relationship between the multiplier and g is positive and reasonably close.

We note, though, that the "5-year" forward real cash flow growth series is based on only four years of data in 1996, three years in 1997, two years in 1998 and a single year in 1999 because cash flow data were not available after 2000. If ex post cash flows through 2003 and 2004, respectively, were used to construct the real growth rate values in 1998 and 1999, the series would undoubtedly have declined, rather than increased, creating a large disconnect between the capitalization factor and the growth rate, suggesting possible irrational pricing. While one could argue that expectations were, in fact, quite high and that the plotted data correctly reflected expectations, such expectations themselves could be construed as evidence of irrationality because rational investors should have been forecasting mean or trend reversion in real cash flows.

A direct comparison of expected (as implied by observed cap rates) and actual forward real cash flow growth rates could be made using the methodology underlying Hall's nominal growth rate comparison, rather than comparing real forward growth with the price-earnings ratio or income multiplier. That is, one could compare the actual real forward growth rate with g calculated as $i - cap$, where i could be computed as the average annual ex post real rate of return on stocks during the period. In this case, a positive, *linear* relationship would again be expected.

We perform this comparison using data from the UK property markets. Figures 7 and 8 plot a constant less the cap rate against the five-year future real rental growth for the UK retail and office markets. (The constant, the average ex post annual real rate of return on property, is computed as the sum of the average cap rate during the period and the average future five-year real rental growth.) While the relationships are positive (the correlation coefficients are 0.52 and 0.30 for the two markets), the relationship for the office market is much weaker than that for the retail market, and there appears to be an inverse relationship between 1977 and 1982 (the correlations for retail and offices for the shorter 1983-2002 period are 0.73 and 0.35).[10]

The inverse relationship during 1977-82 may be due to violation of the assumption of constant real rates of return on property, rather than to irrationality. The late 1970s was a period of unusually low real interest rates worldwide as Central Banks attempted to offset the contractionary impact of the oil price shocks, while the early 1980s was a period of high real interest rates as Central Banks turned to combating inflation.[11] In the absence of this movement in real interest rates, the inverse correlation of the cap rates and the five-year future growth rate in real cash flows would have been stronger. In any event, we interpret these graphs, especially that for retail, as further support in favor of UK investor rationality.

V. Finance-Based Bubbles Tests

Two other tests for bubbles have been conducted in the finance literature and subsequently been applied to property markets. The first is based on the proposition that the variance of actual prices is less than the variance of fundamental values because the latter contain measurement error (Shiller, 1981). Many variance bounds tests of rationality in the market for corporate shares have been undertaken with substantial debate over methods and implications (e.g., LeRoy and Porter, 1981, Kleidon, 1986 and

[10] The low correlation does NOT appear to be due to irrational real growth expectations. Following the argument in note 8, we would expect future real cash flows to be negatively correlated with deviation of the log of real rent from a linear trend. This is, indeed, the case. Using data from 1977-2002, the correlation of the deviation from trend and the growth in real rents over the next five years is –0.87 for offices and –0.84 for retail shops.

[11] For a discussion of U.S. policy during this period, see Feldstein (1994).

Marsh and Merton, 1986). To the best of our knowledge, only two variance bounds tests of the rationality of real estate shares have been executed: Scott (1990) and Brooks *et. al.* (2001), both of which suggest property bubbles.

Scott analyzes an index of the prices of 13 REITs, one of which is a land trust and others of which are really mortgage REITs. The data period is the late 1960s/early 1970s to 1985 (the REITs had varying starting dates). Because Brooks *et. al.* analyze a more homogeneous sample and apply the same basic test, we discuss their study to illustrate the use of these tests and to highlight the difficulties in implementing them.

Brooks *et.al.* examine prices of UK property stocks (the *Financial Times* monthly real estate share index) over the 1986-98 period. They compute two fundamental price series and compare them with the share value series in their figures 2 and 3. Looking at these figures, one wonders why they bothered to conduct their empirical tests. The famous eyeball test indicates clearly that the variance of actual prices is far greater, not less, than that of their fundamental value series.

The question, then, is just why are their two fundamental series so smooth? The series are alternative estimates of the present value of future real dividends and, given their assumption of rational expectations, depend heavily on ex post real dividends. The longer series, which is constructed analogously to the Scott series, computes fundamental value by assuming perfect forecasting of real dividends up until a "reversion date" (the end of the sample) when the fundamental value is assumed to be the current price. A constant real discount rate is assumed.[12] The shorter series that begins in January 1992 is simply a multiple of the previous period dividends. Using the perpetual growth Gordon model, the multiple is $(1+g)/(i-g)$, where i and g, respectively, are the real discount rate and the growth rate in real dividends. For estimates of these, the FT real estate returns and the average growth rate in real dividends for the January 1986-December 1991 period are used; that is, the cap rate and thus the

[12] Geltner and Mei (1995) argue that most changes in property market values are due to changes in nominal discount rates, not in expected future nominal cash flows. Note the use of nominal rather than real values (and that their evidence is based on a single U.S. property cycle, 1975-92). We believe that changes in real property market values are dominated by changes in expected real cash flows rather than in real required returns.

price/dividend multiple are constant. And dividends themselves are a smooth series: as the authors state "it is well known that companies smooth changes [in] dividend payments over time." (p. 348). Using a smooth real cash flow series and assuming a constant real discount rate seems certain to produce a fundamental value series that is less volatile than any actual price series because this approach assumes away changes in real cash flow growth expectations and real discount rates that regularly occur in response to new property and capital market information and economic shocks.[13]

Turning to the 1986-93 property cycle, the Brooks *et. al.* fundamental value series explains only seven percent of the doubling of prices during the 1986-89 boom and none of the subsequent reversal. In contrast, recall that the Hendershott and MacGregor (2005a) model of capitalization rates, where real cash flow growth expectations were based on extrapolation of last year's growth rate and reversion to the long run mean, explained virtually all of the doubling in real office and retail prices and the reversal. That is, large systematic changes in expected real cash flow growth and thus fundamental value largely explain the actual value cycle.

The second test for bubbles drawn from the finance literature is based on the stationarity and cointegration of real stock prices and dividends. Campbell and Shiller (1987) and Diba and Grossman (1988) note that if real stock prices and dividends are produced by difference-stationary processes, then in the absence of explosive bubbles the standard present value model implies cointegration between real stock prices and real dividends. Diba and Grossman conclude that "stock prices do not contain explosive rational bubbles" (p 529).

Evans (1991) provides insights and perspective to these tests. He begins with the standard pricing model that the real stock price at time t is the present value of the expected next period stock price plus dividend. Assuming that conditional expected/required real returns are the constant *i*, we have

$$P_t = \frac{E_t(P_{t+1} + d_{t+1})}{1+i}. \tag{4}$$

[13] Brooks *et. al.* note that "it is vital that this model [of fundamental value] is well specified. It is submitted that a mis-specified model can be misleading and produce false fundamental values." (p 342).

The fundamental value solution to (4) is just equation (1) with *E(d)* replacing *(1-v)R*. The entire class of solutions is given by $P_t = FV_t + B_t$ where FV_t is the fundamental value and B_t is any random variable that satisfies $B_t = E_t(B_{t+1})/(1+i)$. Note that *B* is explosive, i.e., $E_t(B_{t+j}) = (1+i)^j B_t$, and if bubbles exist they have the same return as the asset (*i*) and thus grow over time at rate *i*.

If the difference in real dividends is a stationary ARMA process and there is no *B* satisfying the above process (there are no bubbles), then the fundamental value solution holds and the difference in real price is also a stationary ARMA process and the real price and dividend series are cointegrated. Thus, to paraphrase Evans, if real prices are not more explosive than real cash flows – if real stock prices and real dividends are cointegrated, then bubbles do not exist.

Wang (2000) uses this methodology to test for bubbles in UK property markets. Office, retail and industrial (as well as total) JLW appraised value and rent series were deflated and Johansen cointegration tests were performed on annual data for the 1977-97 period. Cointegration was found for all markets except the industrial sector. That is, bubbles could be ruled out at conventional statistical levels.[14]

Unfortunately, this methodology only identifies noncollapsing bubbles (Evans, 1991). That is, as Wang notes, the method may be inappropriate for a retrospective on a past bubble because bubbles that have already burst will not be recognized. Rather, this approach seeks to identify the "first half" of a bubble. If UK property values experienced a bubble peaking in 1990, we would not expect it to be identified using an estimation period ending in 1997 (as in Wang). An estimation period ending in 1990 would be better suited to judge whether a bubble in fact occurred.

VI. Summary

Periodic sharp sustained increases and then reversals in real asset prices have led many to speak of irrational price bubbles. The worldwide commercial property boom in the late 1980s and the early

[14] Wang also tests for and finds evidence of inefficiencies in the property market. Presumably these reflect the high transactions costs and long production lags discussed in Section I above.

1990s reversal is the example most relevant to us. The general case for bubbles is that real asset prices simply move too much given the real cash flows the assets are likely to produce. High real cash flows will generate competitive responses (e.g., additional commercial space) that will reduce future cash flows. Thus real prices should be less volatile than real cash flows.

Sharp price movements are not necessarily evidence of irrationality. If investors' best perception of fundamentals (future cash flows) improves rapidly and then deteriorates, a price spike is required in an efficient market. High transactions costs and long production lags, characteristics of direct or unsecuritized real estate, contribute to greater price variability as do principal-agent problems that cause the actions of agents (fund managers/loan officers) to be at odds with principals (investors) interest in quickly curtailing supply. Whether property price swings reflect sharp enough departures from fundamental values to imply that investors are either betting on an equivalent to the greater fool theory or simply do not understand how property markets work is difficult to judge. But a number of attempts have been made.

Evidence from Sydney, Stockholm, Kong Kong, Singapore, and US cities suggests irrationality during the late 1980s property boom. In all cases, real property prices rose more rapidly than real rents and did not turn around prior to the real rent peak. That is, capitalization rates rose (value/rent ratios fell) with real rents, implying that investors did not build mean reversion into their real cash flow expectations. While high selling costs and long production lags prevent nonsecuritized real estate prices from adjusting quickly to changes in real cash flow expectations, real prices got so far out of line with real cash flows in these markets as to leave little doubt about irrational pricing.

We then reviewed Hall's (2001) tests of an irrational US stock market bubble. Hall presents a relatively crude test of three joint hypotheses: the real risk premium is constant, five-year future real cash flow growth approximates expected future real cash flow growth, and investors are rational. His results are largely consistent with the joint hypotheses and thus with rationality, although this almost certainly would not be the case if his data sample were extended beyond the turn of the century. (The results are not consistent when the growth hypothesis is stated in nominal terms, presumably because investors have not been good inflation forecasters.)

When we apply a similar test to UK office and retail property data, there is some evidence of rationality. Further evidence of rationality in UK property markets is contained in Hendershott and MacGregor's analysis of UK capitalization rates. For both office and retail properties, the capitalization rate is negatively related to proxies for expected real cash flow growth (investors will pay more for a dollar of rent if rent is expected to grow more rapidly). Expected real cash flow growth is based on both extrapolation of recent real growth and reversion of real cash flows to their long run trend.

Lastly we considered the application of formal finance tests to the property market. We argue that the "variance bounds" tests performed to date on securitized real estate have been ill designed, if not fundamentally flawed. The calculated fundamental real value series are based on smoothed real cash flows (dividends rather than earnings) and assume constancy in real discount rates. It is thus hardly surprising that measures of real asset values are more volatile than such series. While cointegration tests have not revealed bubbles, these tests are able to identify only noncollapsing bubbles and thus are not very useful. It is, after all, the collapse that generally identifies the bubble.

To summarize, with the exception of the UK property market, data and statistical tests from numerous countries suggest that an irrational commercial property bubble developed in the late 1980s worldwide and deflated in the early 1990s. The relevant question at this point is whether investors learned from that episode. Thus future research should concentrate on data subsequent to that cycle, i.e., after 1993. Along these lines, Hendershott and MacGregor (2005b) interpret late 1990s and early 2000s data as suggesting that US investors learned about mean reversion from the 1986-93 experience.

References

Ball, M, C. Lizieri, and B. D. MacGregor, The Economics of Commercial Property Markets, Routledge, London, 1998.

Barbeis, N., A. Shleifer and R. Vishney, "A Model of Investor Sentiment," Journal of Financial Economics, 49, 1998, 307-343.

Barsky, R. and B. De Long, "Why Does the Stock Market Fluctuate?," Quarterly Journal of Economics, 107, 1992, 291-311.

Bjorklund, K. and B. Soderberg, "Property Cycles, Speculative Bubbles and the Gross Income Multiplier," Journal of Real Estate Research, 18, 1999, 151-174.

Brooks, C., A. Katsaris, T. McGough and S. Tsolacos, "Testing for Bubbles in Indirect Property Price Cycles," Journal of Property Research, 18, 2001, 341-356.

Brunnermeier and Nagel (2004)

Campbell, J. Y. and R. J. Shiller, "Cointegration and Tests of Present Value Models," The Journal of Political Economy, 1987, 95, 1062-88.

Capozza, D. R., P. H.Hendershott, and C. Mack, "An Anatomy of Price Dynamics in Illiquid Markets: Analysis and Evidence from Local Housing Markets," Real Estate Economics, 2004, 32, 1-32.

Chen, J., S. Hudson-Wilson, and N. Nordby, "Real Estate Pricing: Spreads & Sensibilities: Why Real Estate Pricing is Rational," Journal of Real Estate Portfolio Management, 2004, 10, 1-22.

Daniel, K. D., D. Hirshleifer and A. Subrahman, "Investor Psychology and Security Market Under- and Over-reactions," Journal of Finance , 53, 1998, 1839-1886.

Diba, B. T. and M. L. Grossman, "Explosive Rational Bubbles in Stock Prices?," The American Economic Review, 1988, 78, 520-30.

Evans, G. W., "Pitfalls in Testing for Explosive Bubbles in Asset Prices," The American Economic Review, 1991, 81, 922-930.

Feldstein, M., "American Economic Policy in the 1980s: A Personal View," in Feldstein (ed), American Economic Policy in the 1980s, The University of Chicago Press, 1994, 1-80.

Gelner, D. and J. Mei, "The Present Value Model with Time-Varying Discount Rates: Implications for Commercial Property Valuation and Investment Decisions," Journal of Real Estate Finance and Economics, 1995, 11, 119-135.

Gentry, W. and C. Mayer, "The Role of Stock Prices versus 'Fundamental' Value for Investment and Capital Structure Decisions: Evidence from Real Estate Investment Trusts," mimeo, January 2003.

Hall, R. E., "Struggling to Understand the Stock Market," The American Economic Review, 91, 2001, 1-11.

Hendershott, P. H., "Property Asset Bubbles: Evidence from the Sydney Office Market," Journal of Real Estate Finance and Economics, 20, 2000, 67-81.

__________, "Rental Adjustment and Valuation in Overbuilt Markets: Evidence from the Sydney Office Market," Journal of Urban Economics, 39, 1996, 51-67.

Hendershott, P. H., R. J. Hendershott, and C. R.Ward, "Corporate Equity and Commercial Property Market 'Bubbles'," Urban Studies, 40, 2003, 993-1009.

Hendershott, P. H. and B. D. MacGregor, "Explaining UK Office and Retail Capitalisation Rates Using an Error Correction Model," Real Estate Economics, 33, 2005a, 299-332.

__________, "Investor Rationality: An Analysis of NCREIF Commercial Property Data," Journal of Real Estate Research, 2005b.

Hong, H. and J. C. Stein, "A Unified Theory of Underrreaction, Momentum Trading and Overreaction in Asset Markets," Journal of Finance, 1999, 54, 2143-84.

Jegadeesh, N. and S. Titman, "Returns to Buying Winners and Selling Losers: Implications for Stock Market Efficiency," Journal of Finance, 1993, 48, 65-91.

Jegadeesh, N. and S. Titman, "Profitability of Momentum Strategies: An Evaluatioin of Alternative Explanations," Journal of Finance, 2001, 56, 699-720.

Kleidon, A., "Variance Bounds Tests and Stock Price Valuation Models, Journal of Political Economy, 1986, 94, 953-1001.

LeRoy, S. and R. Porter, "The Present-Value Relation: Tests Based on Implied Variance Bounds," Econometrica, 1981, 49, 555-574.

Lui, C. H. and J. Mei, "An Analysis of Real Estate Risk Using the Present Value Model," Journal of Real Estate Finance and Economics, 1994, 8, 5-20.

Marsh, T. and R. Merton, "Dividend Variability and Variance Bounds Tests for the Rationality of Stock Market Prices, American Economic Review, 1986, 76, 483-498.

Ofek, E. and M. Richardson, "Dot-com Mania: The Rise and Fall of Internet Stock Prices," Journal of Finance, 2003, 58, 1113-1138.

Quigley, J., "Real Estate Prices and Economic Cycles," International Real Estate Review, 1999, 2, 1-20.

Schleifer, A. and L. H. Summers, "The Noise Trader Approach to Finance," Journal of Economic Perspectives, 1990, 4, 19-33.

Scheinkmark and Xiong (2003)

Schleifer, A. and R. Vishney, "The Noise Trader Approach to Finance," Journal of Economic Perspectives, 1998, 4, 19-33.

Scott, L. O., "Do Prices Reflect Market Fundamentals in Real Estate Markets?" Journal of Real Estate Finance and Economics, 1990, 3, 5-23.

Sivitanides, P. J., R. G. Southard, R. G. Torto and W.C. Wheaton, “The Determinants of Appraisal-Based Capitalization Rates,” Real Estate Finance, 18, 2001, 27-37.

Shiller, R., “Do Stock Prices Move too Much to be Justified by Subsequent Changes in Dividends?,” American Economic Review, 71, 1981, 421-436.

__________, Irrational Exuberance, Princeton, Princeton University Press, 2000.

Wang, P., “Market Efficiency and Rationality in Property Investment,” Journal of Real Estate Finance and Economics, 2000, 21, 185-201.

Wheaton, W. C. and R. G. Torto, “Office Market Rent Indices and Their Behavior over Time,” Journal of Urban Economics, 35, 1994, 121-139.

Wheaton, W.C., R. G. Torto, R. S. Sivitanides, J. A. Southard, R. E. Hopkins, and J. M. Costello, “Real Estate Risk: A Forward-Looking Approach,” Real Estate Finance, 18, 2001, 20-28.

Figure 1: Dot-com Stock Prices and Internet IPOs (HHW, 2003)

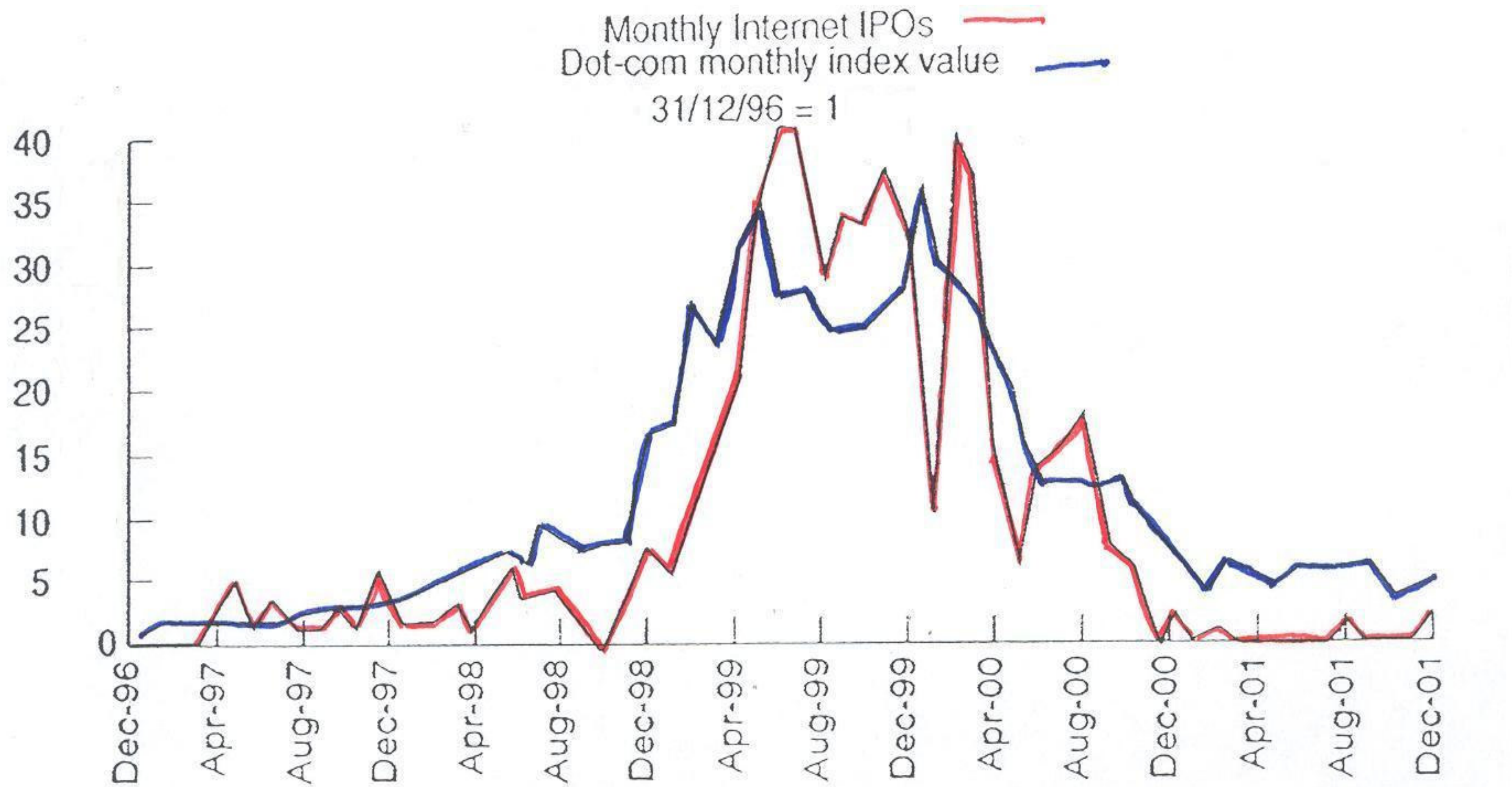

Figure 2: Sydney Office Market; A 100% Bubble

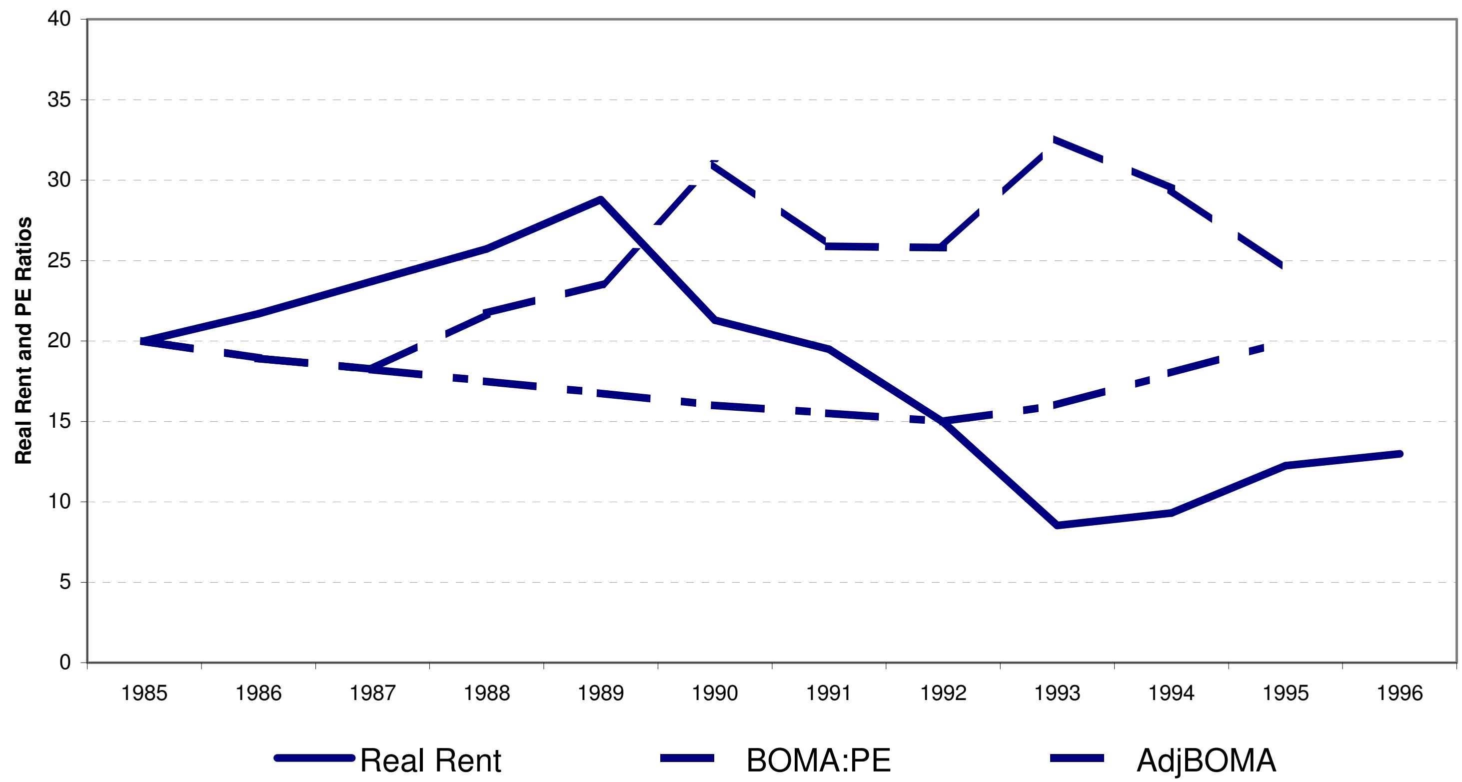

Figure 3: Cap Rates and Real NOI Deviations – Southern California Industrial

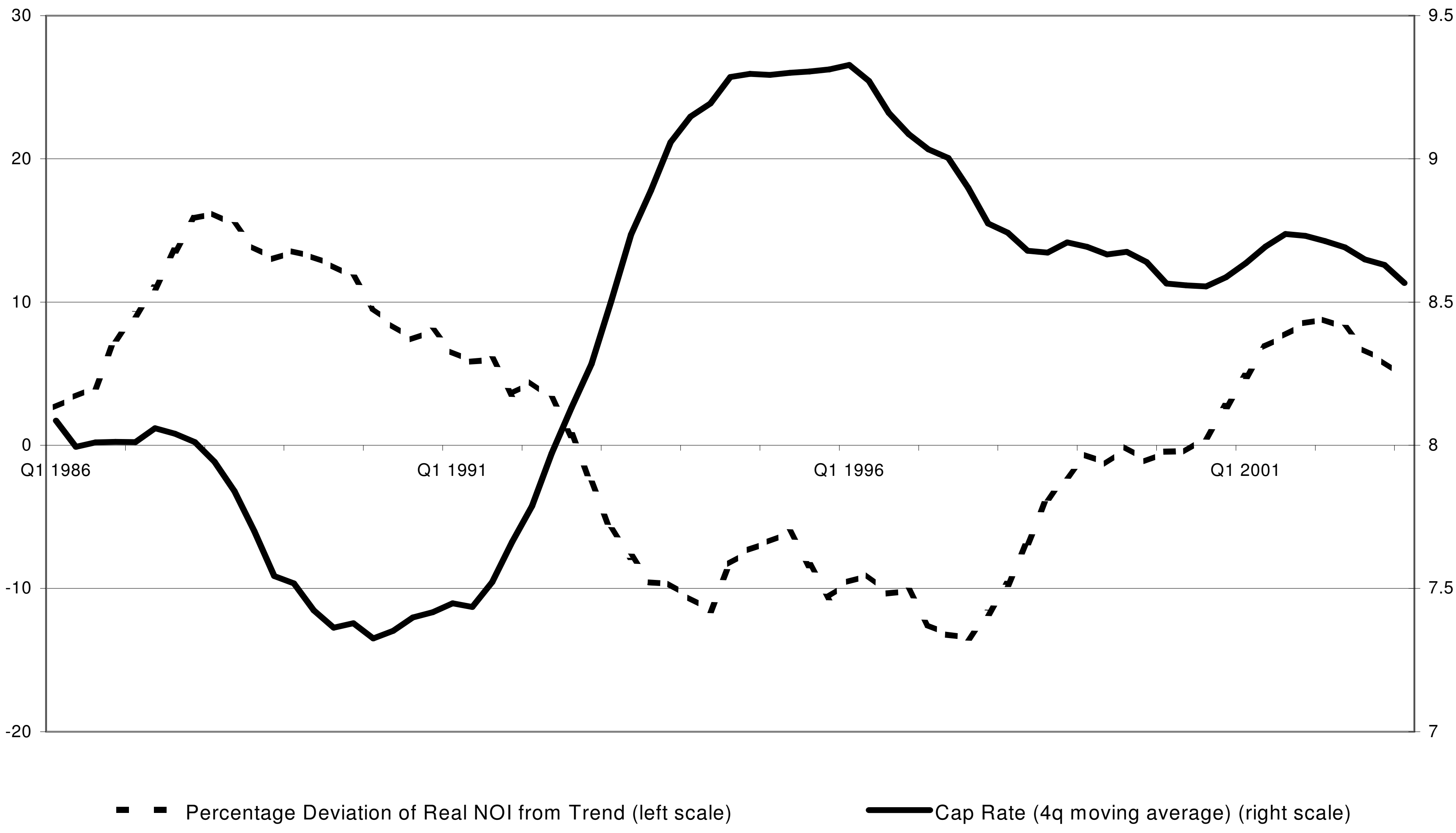

Figure 4: Cap Rates and Real NOI Deviations – Southern California Offices

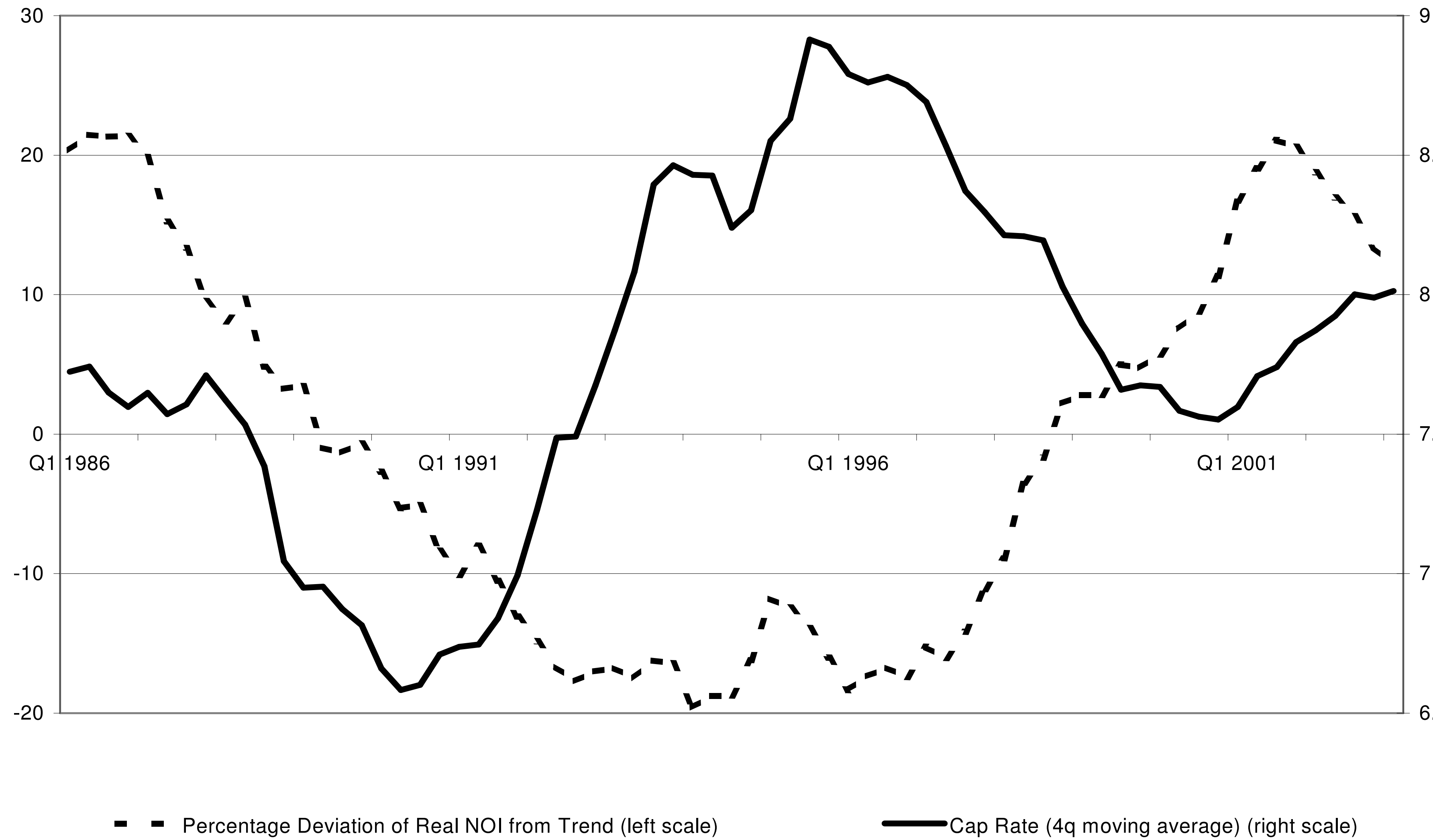

Figure 5: The UK Office Market Price-to-Rent Ratio and Real Cash Flow Growth

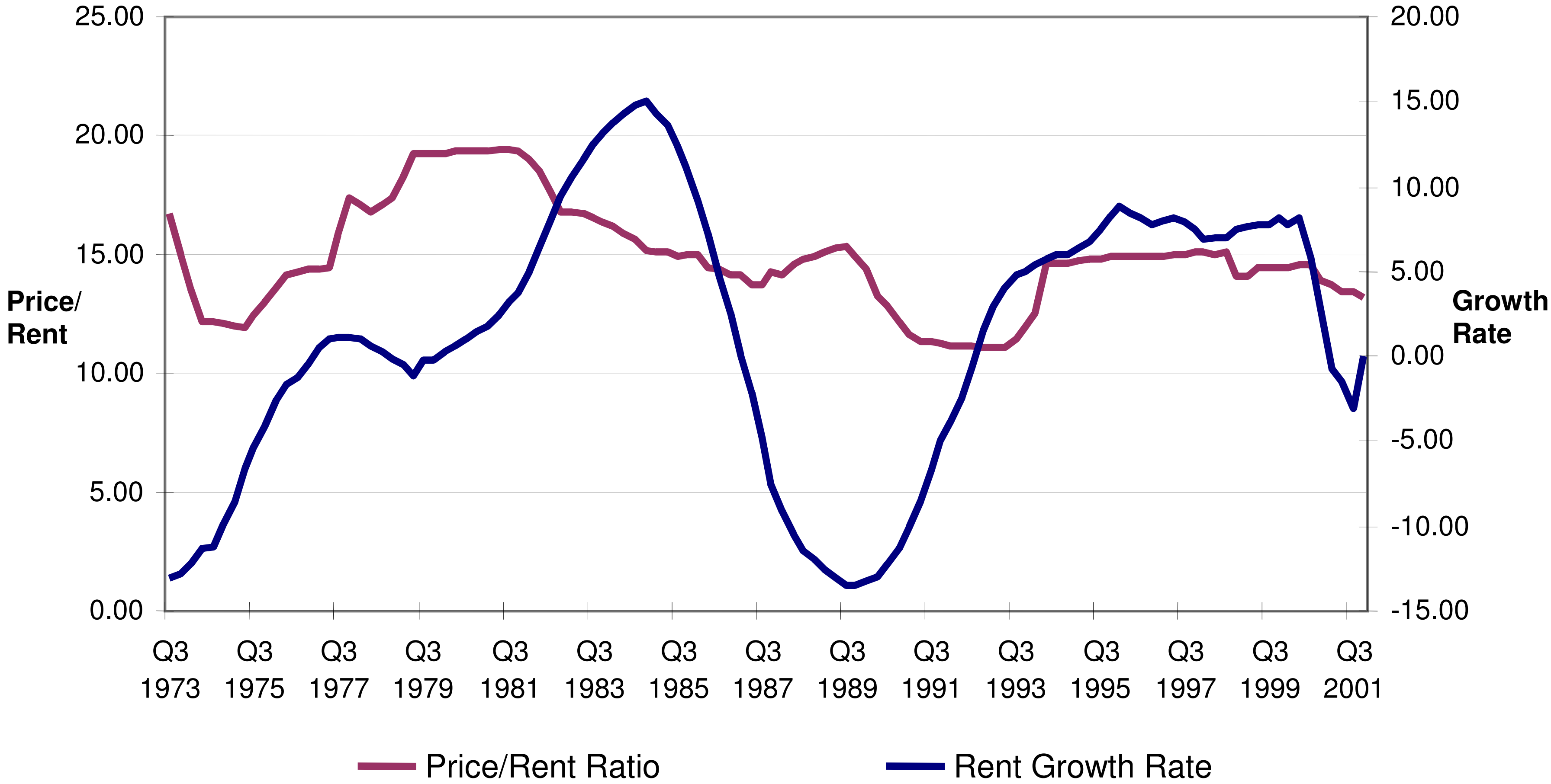

Figure 6: The UK Retail Market Price-to-Rent Ratio and Real Cash Flow Growth

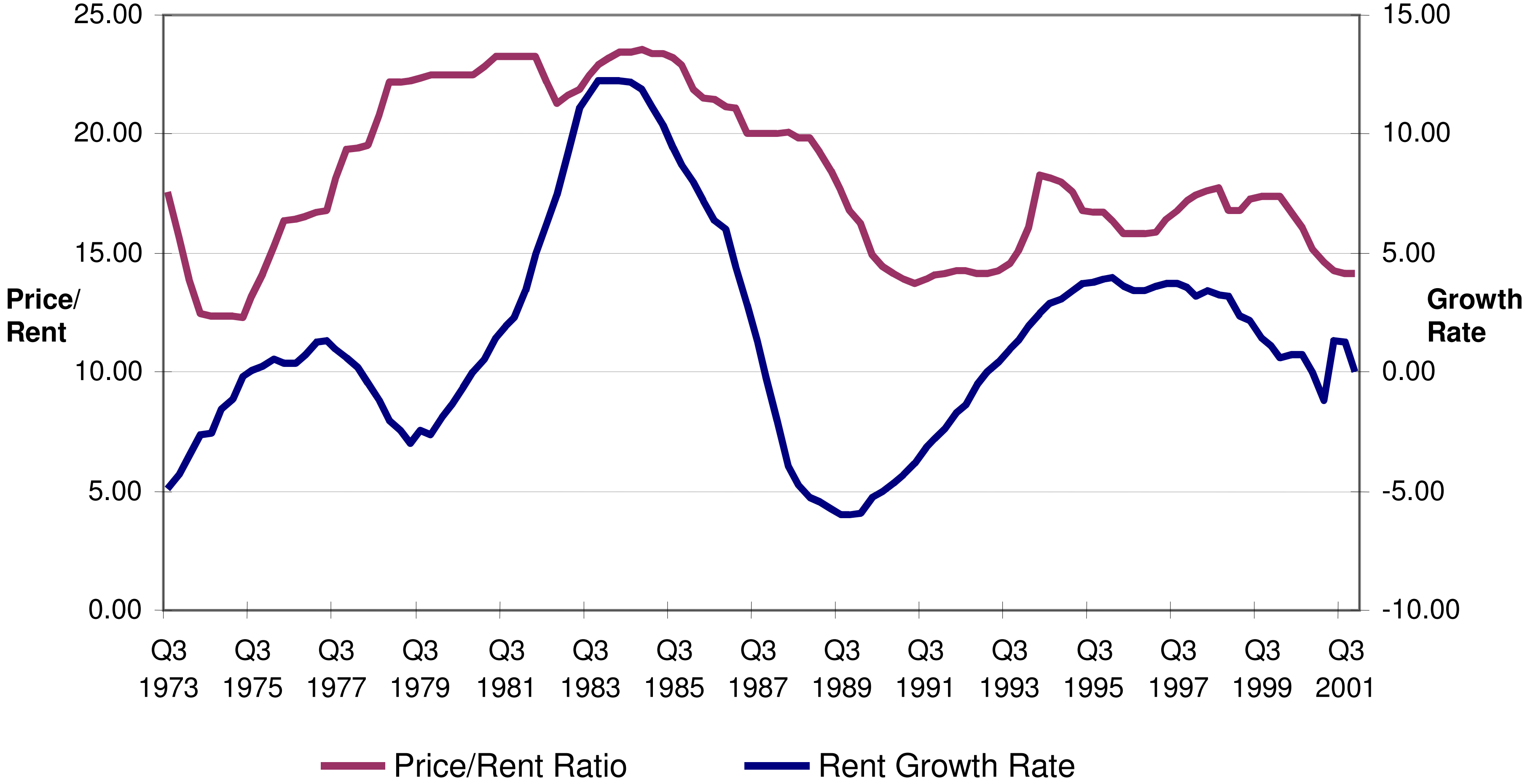

Figure 8: UK Office 5 yr Future Real Cash Flow Growth and Sum of Means Less Office Cap Rate

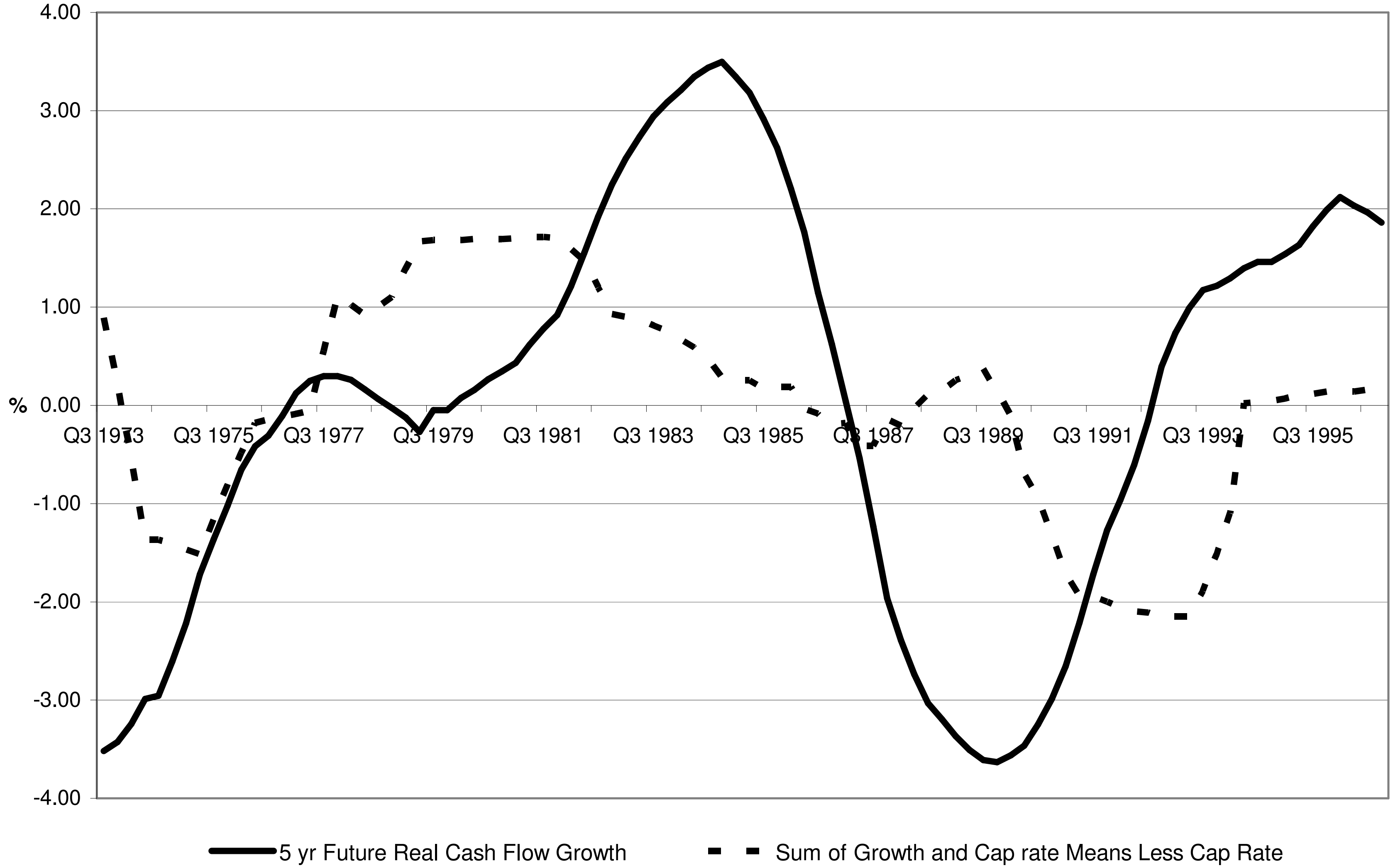

Figure 9: UK Retail 5 yr Future Real Cash Flow Growth and Sum of Means Less Retail Cap Rate