

# Evaluating Unsmoothing Procedures for Appraisal Data

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## Abstract

In this paper we investigate alternative methods of adjusting appraisal-based real estate returns to correct for the perceived biases induced in the appraisal process. Since the early work by Geltner (1989), many papers have been written on this topic but remarkably few have provided a detailed statistical evaluation of the proposed unsmoothing methods. To provide a comparison we apply bootstrapping procedures to a sample of individual-property level appraisal data from the Investment Property Database (IPD) to construct aggregate property return series. Applying commonly used unsmoothing methods to these series enables us to draw valuable conclusions about the effectiveness of such procedures in recovering information about the moments of commercial real estate returns.

## 1 Introduction

One of the topics in real estate research that has received significant attention has been the treatment of appraisal-based returns. Recent evidence from a review of real estate articles suggests that research on this topic dominates the citation list in real estate journals (Domrow and Turnbull 2004). While attempts have been made to construct transaction-based returns series, use of appraisal-based returns remains common in academic literature and is almost exclusively used in commercial research applications. There is a widespread belief among academics that such appraisal-based returns do not accurately represent the underlying movements of the commercial property asset class as biases are introduced in the appraisal process by appraisers seeking to dampen volatility in their price estimates. This view is based on the well known findings

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of Quan and Quigley (1991) and also confirmed empirically in Clayton, Geltner and Hamilton (2001). Other factors also induce econometric problems with appraisal-based indices, such as aggregation, as these issues have been discussed in Geltner (1993a) and Bond and Hwang (2005).

The general response to this problem has been to apply a statistical filter to the appraisal-based returns to remove all or part of the autocorrelation in the series. The corrected or "unsmoothed" series is then taken to more accurately reflect the movements in the "true" returns process. The most common statistical filtering procedures are based on Geltner (1991, 1993b) and Fisher, Geltner and Webb (1994). More recent work has been conducted by Brown and Matysiak (1998), Cho, Kawaguchi and Shilling (2003), Edelstein and Quan (2004) and Bond and Hwang (2003, 2005) and a useful survey of the literature has been provided by Geltner, MacGregor and Schwann (2003). However, work on smoothed returns is not confined to real estate and is also discussed for other asset classes, such as hedge funds, by Getmansky, Lo and Makarov (2003).

Given the extensive volume of research on this topic and the many "unsmoothing" procedures that have been suggested, there has been little research evaluating the suggested procedures and assessing their accuracy. Exceptions to this include Giacotto and Clapp (1992), who provide monte carlo evidence on appraisal smoothing behavior, and Edelstein and Quan (2004) who compare appraisal returns with transaction information to assess the impact of smoothing. Such research, while helpful in understanding the problem, does not always assist empirical researchers faced with a choice of whether to use unsmoothed returns and if so what unsmoothing procedure should be adopted. The goal of this research is to provide some guidance on the choice between commonly used unsmoothing procedures. To do this we utilize data on individual property appraisal from the Investment Property Databank (IPD) for UK commercial real estate. This dataset is very similar to the NCREIF data commonly used in US research. Because of the similarity of construction methods it is believed conclusions derived from using UK data will still have relevance to researchers using NCREIF data or similar appraisal-based data in other countries.

Our methodology is to use bootstrapping techniques on a sample of individual property returns to generate alternative aggregate index series. Knowing the individual property returns allows us to form an estimate of the "true" underlying returns process using similar methods to Giacotto and Clapp (1992). We then apply commonly used unsmoothing procedures to the aggregate indices generated from the boot-strapped data and draw conclusions about the efficacy of such procedures.

The layout of the paper is as follows. The next section discusses the unsmoothing problem and provides a brief overview of the related literature. Section 3 describes the methodology used in this study and the sampling procedure for the individual IPD property returns. Section 4 applies the key unsmoothing techniques to the bootstrapped return series and evaluates their effectiveness. Section 5 concludes the paper.

## 2 Smoothing in Real Estate Returns

To understand the issue of smoothing in real estate returns, consider the model of smoothing described in Bond and Hwang (2005). Start with the assumption that asset returns follow a mean plus noise process;

$$r_{it} = \mu_i + \sigma_i \varepsilon_{it} \quad (1)$$

where  $r_{it}$  is the log-return of asset  $i$  at time  $t$ ,  $\varepsilon_{it} \stackrel{iid}{\sim} N(0, 1)$ , and  $\mu_i$  and  $\sigma_i$  are the expected return and standard deviation of the log-returns per unit time respectively.

It is commonly assumed in models of smoothing that past information affects current price with an exponentially decreasing weight, that is, the innovation at time  $t$ ,  $\varepsilon_{it}$ , is not fully reflected at time  $t$ , but over time with an exponential rate<sup>1</sup> When the rate is  $\phi_{si}$ , the smoothed return process for asset  $i$ ,  $r_{sit}$ , is

$$r_{sit} = \mu_i + (1 - \phi_{si})\sigma_i \varepsilon_{sit}, \quad (2)$$

where

$$\varepsilon_{sit} = \phi_{si} \varepsilon_{sit-1} + \varepsilon_{it}.$$

In this model,  $\phi_{si}$  is an AR parameter for the level of smoothing, where  $0 \leq \phi_{si} < 1$ . Note that  $1 - \phi_{si}$  in (2) is necessary to make the sum of the weights on past innovations one so that asset returns do not under or over reflect the innovations in the long run. The smoothed process in (2) can be written as

$$\begin{aligned} r_{sit} - \mu_i &= \phi_{si}(r_{sit-1} - \mu_i) + \sigma_{si} \varepsilon_{it} \\ &= \phi_{si}(r_{sit-1} - \mu_i) + (1 - \phi_{si})(r_{it} - \mu_i), \end{aligned} \quad (3)$$

where  $\sigma_{si} = (1 - \phi_{si})\sigma_i$ . When  $\phi_{si} = 0$ , there is no smoothing and the return process in (3) is the same as the data generating process in equation (1). On the other hand, as  $\phi_{si}$  becomes larger, the relative weight on the current information ( $\varepsilon_{it}$ ) decreases and the past information ( $\varepsilon_{it-1}, \varepsilon_{it-2}, \dots$ ) becomes more important in the return process.

The variance and autocorrelation of the smoothed return process are

$$\begin{aligned} Var(r_{sit}) &= \frac{(1 - \phi_{si})}{1 + \phi_{si}} \sigma_i^2 \\ Cor(r_{sit}, r_{sit-\tau}) &= \phi_{si}^\tau \text{ for } \tau = 1, 2, \dots \end{aligned} \quad (4)$$

The variance of smoothed returns decreases by  $\frac{1 - \phi_{si}}{1 + \phi_{si}}$  times and thus is less volatile than the true process; i.e.,  $Var(r_{sit}) < Var(r_{it})$  for  $0 \leq \phi_{si} < 1$ . However, the expected return ( $\mu_i$ ) remains unchanged by the smoothing procedure.

### 2.1 Review of the Literature

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<sup>1</sup>Getmansky, Lo and Makarov (2003) assume that the innovation at time  $t$  is reflected over a finite period with a specific rate.

### 3 Methodology

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### 4 Data and Results

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### 5 Conclusion

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