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Transaction-Based and Appraisal-Based Capitalization Rate Determinants

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This paper contributes to the debate about capitalization rate determinants by comparing the driving factors of appraisal-based cap rates with those of transaction-based cap rates. By using a rich database of real estate transactions in Switzerland for the period of 1985–2010, we identify several property-specific variables that have not been used in prior research and that increase the explained portion of the cap rate variance by as much as 10 percentage points. The results show that compared to investors, appraisers overweight factors that they can easily observe when they appraise a property, at the cost of variables related to growth expectations and the opportunity cost of capital. This has two implications. First, as the easily observable factors hardly change over time, while the latter variables change frequently and significantly, it provides new evidence that may add to the appraisal-smoothing discussion. Second, investors put less emphasis on factors that are diversifiable, which suggests that they favor a portfolio perspective, whereas the focus of the appraisers is more on the individual property level.

Keywords

Appraisal-Based Capitalization Rates; Transaction-Based Capitalization Rates; Real Estate Risk; Appraisal Smoothing; Valuation

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1. Introduction

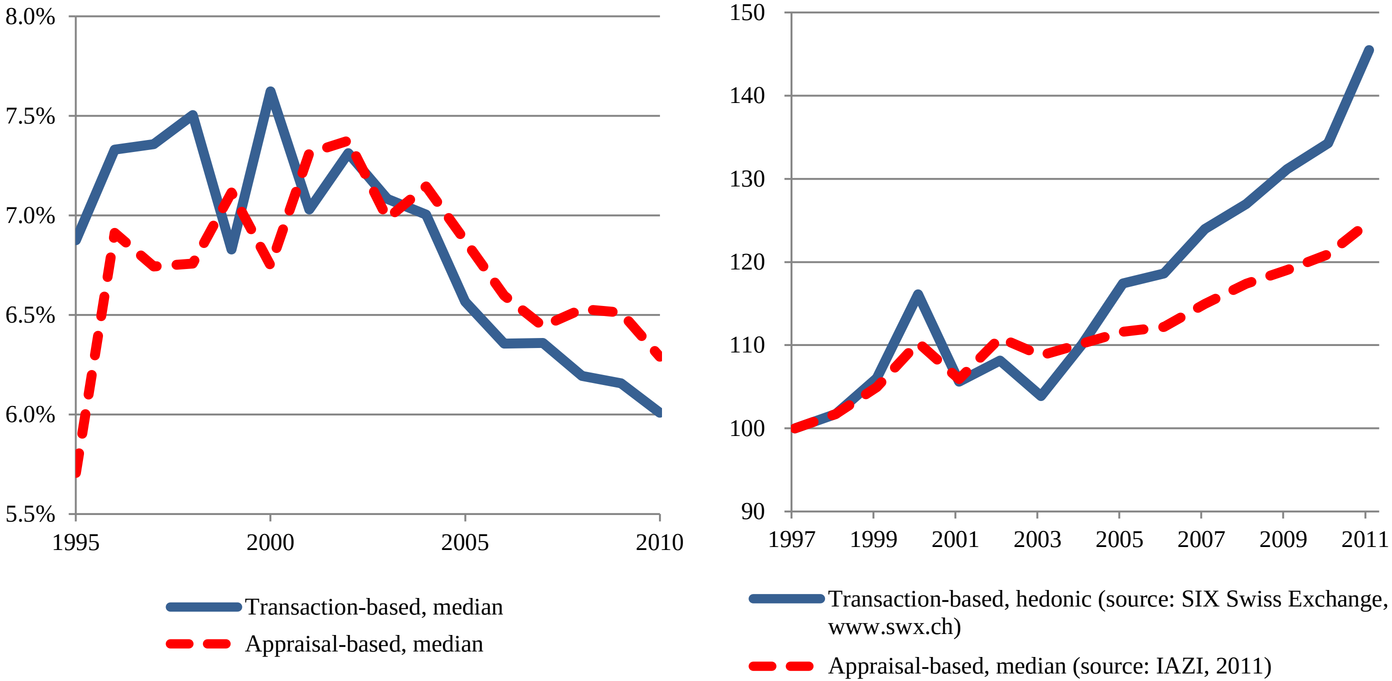
The goal of this paper is to contribute to the literature by examining the driving factors of commercial property prices. Our focus is on the capitalization rate (cap rate), which is one of the most important metrics for real estate investment analysis. The cap rate is defined as the ratio between the net operating income (NOI) produced by an asset and its market value, thus constituting the rate at which the NOI is capitalized to derive the price of the asset. The cap rate is also the inverse of the price-to-earnings (P/E) ratio that is widely used for stock valuation.

Given that there is some evidence of a mismatch between valuations and transaction prices (Cole et al., 1986; Fisher et al., 1999; Cannon & Cole, 2011), this paper focuses on the cap rate determinants of appraisers (valuations) and investors (transaction prices). To detect differences and similarities in the pricing between these two market participants, we work with a unique dataset of implicit cap rates extracted from both valuations and transactions that took place in Switzerland. Figure 1 provides a comparison of the median appraisal-based and transaction-based cap rates over the period of 1995–2010. The two cap rate series share a similar trend, but differ notably in the short run. Figure 1also shows indices of Swiss real estate prices constructed with valuations and transaction prices, respectively. The appraisal-based index exhibits less volatility than the transaction-based index.

It is often argued that compared with transaction prices, valuations tend to be lagged and that the returns calculated from appraised values are smoothed. If appraisers do not feel perfectly confident with their appraisal estimates when relying on current market information only, it is rational for them to also rely on past information. This leads to a moving average of current and past value estimates, which by definition, creates serial correlation and hence the smoothing effect. After the development of the partial adjustment model by Blundell & Ward (1987), Geltner (1989, 1991) and Quan & Quigley (1989, 1991), many authors have found empirical support for appraisal smoothing (Matysiak & Wang, 1995; Diaz & Wolverton, 1998; Fisher & Geltner, 2000; Clayton et al., 2001; Edelstein & Quan, 2006; Cannon & Cole, 2011).

However, not all researchers agree with the widely accepted view that smoothing exists. For example, Lai & Wang (1998) point out that traditional appraisal-smoothing arguments are limited by the assumptions upon which the arguments are based and that under certain assumptions, the variance of appraisal-based returns could even be higher (not lower) than that of the true returns. Cheng et al. (2011) demonstrate that the degree of heterogeneity of appraisers will determine whether the appraisal-based variance is smoothed or exceed the true variance. This has been further analyzed by Bond et al. (2013), who use a large sample of appraisal data at the individual property level to empirically estimate the smoothing at both the individual property and

Figure 1 Transaction-Based vs. Appraisal-Based Cap Rates (Left) and Prices (Right)



the aggregate index levels. They observe a high degree of persistence in the aggregate index and a smaller one at the individual property level.

Despite the abundant literature, the discussion about potential mismatches between valuations and transaction prices in general and appraisal smoothing in particular has not reached a consensus. Given that (1) indices – whether smoothed or not – are either based on valuations or transactions of individual properties, and (2) that there is some evidence of a mismatch between valuations and transaction prices, we maintain that it is important to improve the understanding of the similarities and differences between the driving forces of those valuations and transactions.

By analyzing these driving factors, the paper contributes to the existing literature in three ways. Most importantly, we are the first to investigate the differences between the determinants of appraisal-based and transaction-based cap rates. Provided that many studies document the potential limitations of valuation-based data and that such data are often used as a proxy for transaction-based data, a comparison of cap rate determinants should prove useful in assessing the causes of potential biases that may result from using valuation-based data. Our hypothesis is that investors are more concerned with the opportunity cost of capital than appraisers, thus linking cap rates more strongly to capital markets, while appraisers have a stronger focus on what they directly observe when they appraise a property, i.e. property characteristics. Property-specific variables hardly change over time, while capital market variables change frequently and significantly. If appraisers were indeed to overweight property-specific information at the cost of capital market information, the resulting values would likely be smoothed.

We also contribute to the literature by expanding the body of knowledge on micro-level cap rates as we (1) explicitly determine the relative importance of the various cap rate components, and (2) test for the significance of several property characteristics that have not been considered so far, i.e., the percentage of regulated rents, building condition, construction quality, existence of easements, tenant diversification, and tenant quality. We expect the cap rate to be higher if the rent is earned from similar types of tenants of poor quality, when a high percentage of rents are regulated, and for buildings that have easements, are of bad construction quality, and are in poor condition.

Finally, transaction-based micro-level studies to date have relied on data from usually one, and at most three cities, with a typical sample size of a few hundred observations. Our data encompass almost 20,000 observations that are spread over 1,000 localities from a market that has not previously been considered in the cap rate literature. This study therefore helps to determine whether the findings of the few previous micro-level studies were specific to the properties in the selected cities, or whether they are more generally applicable. This is important as research from aggregated cap rate data has shown that local market conditions are crucial when explaining variations in cap rates.

Our results show that compared to investors, appraisers overweight factors that they can easily observe when they appraise a property, at the cost of variables related to growth expectations and the opportunity cost of capital. This has two implications. First, it adds to the discussion on appraisal-smoothing, as the easily observable factors hardly change over time, while the latter variables change frequently and significantly, thereby pointing to a new explanation for the cause of the potential smoothing effect. Second, investors place less emphasis on factors that are diversifiable, which suggests that they use a portfolio perspective, whereas appraisers are more concerned with the individual property.

The remainder of the paper is organized as follows. The next section provides a review of the literature that concerns cap rates. The subsequent two sections focus on the method and data, respectively. We then discuss our results, before concluding in the final section.

2. Literature Review

Previous cap rate studies can be divided into two main streams that differ with respect to the level at which the variation in cap rates is analyzed. The first line of research focuses on the variation at the macro level by analyzing aggregate cap rate data that vary by Metropolitan Statistical Area (MSA) and/or over time. Early work includes Nourse (1987) who studies time series of national appraisal-based cap rates for multifamily and non-residential properties from the American Council of Life Insurance (ACLI). He finds that debt service payments have a positive effect on the cap rate, while the percentage of the loan that has been amortized has a negative effect. Froland(1987) examines the same ACLI data and reports that the debt yield is positively correlated with the cap rate, while inflation expectations and indicators of economic cycles, including capacity utilization, national vacancy rate, and the percentage change in real gross national product, are negatively correlated with cap rates. The ACLI cap rate series are also found to be auto-correlated and positively linked with the earnings/price ratio of the stock market with a lag of one quarter (Evans, 1990). Ambrose & Nourse (1993) also analyze ACLI data for several property types. Cap rates are found to be negatively related to the earnings/price ratio for the S&P 500 index and positively related to the percentage of equity investment, cost of debt, and expected inflation.

More recently, Clayton et al. (2009) analyze the role of investor sentiment based on data from investment surveys for nine property types over the period of 1996Q1–2007Q2. They find the 10 year T-bond yield and the risk premium to be positively linked with the cap rate, while the expected rent growth has a negative influence. Their sentiment measures do not deliver conclusive results. Chervachidze et al. (2010) and Chervachidze & Wheaton (2013) analyze a panel data set for 30 MSAs and four property types for the period of 1980Q1–2007Q4 and 1980Q1–2009Q3, respectively. They show that the corporate risk premium and the net amount of debt issued in the economy are useful in explaining the macro-level variation in cap rates.

Several researchers have focused on the relation between cap rates and rental growth, arguing that real cash flows are necessarily trend reverting, whereby actual cash flows above trend imply slower future real cash flow growth and thus higher cap rates. Sivitanides et al. (2001) investigate annual office cap rates from the National Council of Real Estate Investment Fiduciaries (NCREIF) database for 14 U.S. metropolitan areas during 1984 and 2000. They find that when real rents are high, investors expect them to go higher and thus they capitalize current rent with a lower than normal cap rate, which suggests irrational behavior. Chen et al. (2004) also find a negative relationship by using 1982–2002 NCREIF data. However, they interpret the ratio of current to mean real rent as a determinant of the risk premium required on real estate, not ofthe expected real cash flow growth rate. They argue that lower premiums are required in ‘hot’ markets and hence that the negative coefficient on the ratio is consistent with rationality. Hendershott & MacGregor (2005a) investigate NCREIF data further for the 1986Q1–2003Q1 period by considering office, retail, and industrial properties, and find the same negative relation. They conclude that U.S. investors appear to have behaved irrationally in that they did not factor expectations of mean reversion of real cash flows into their asset pricing as reflected in capitalization rates. In contrast to the behavior of U.S. NCREIF data, evidence from the U.K. office and retail markets suggests that U.K. investors did build mean or trend reversion into their valuations (Hendershott & MacGregor, 2005b).

All these macro-level studies are appraisal-based and with the exception of the paper by Hendershott & MacGregor(2005b), all analyze U.S. data. A few U.S. studies that use transaction-based data are also available (Jud & Winkler, 1995; Sivitanidou & Sivitanides, 1996, 1999), but the cap rates used are simple averages and lack quality adjustment (Hendershott & Turner, 1999). To summarize, the macro-level stream is dominated by appraisal-based U.S. studies which document that local market conditions (such as vacancy rates, absorption, size of the market, and supply constraints), the deviation of the current property market from its trend, and information from the capital markets (e.g., capital supply and the required rate on alternative investments such as stocks and bonds) help to explain the variation in the cap rate data.

The second line of research analyzes micro-level variations by focusing on the individual property as the unit of observation. This micro-level stream has used both appraisal-based and transaction-based cap rates, but analyzed data from just a few cities. Early work includes Saderion et al. (1994) who analyze

500 transactions of apartment complexes in Houston between 1978 and 1988. They find that cap rates systematically vary with respect to project size and age as well as with location. More recently, McDonald & Dermisi (2008, 2009) use 132 office building sales in Chicago between 1996 and 2007. They find that a lower cap rate is associated with a lower risk-free rate, class A buildings, newer buildings, buildings that had been renovated, a reduction in the market's vacancy rate, and an increase in employment.

Besides evidence from those two U.S. cities, studies of property-specific cap rates have relied on Sweden for data. Hendershott & Turner (1999) compute constant-quality cap rates based on 403 property transactions in Stockholm from 1990 to 1992. They find that cap rates are lower for properties with below-market financing, better locations, more apartment usage (as opposed to commercial usage), and lower density (measured as the ratio of building space to lot size). They emphasize that quality adjustment of cap rates is important, since they find wide disparities between their constant-quality cap rate series and simple averages. Janssen et al. (2001) also analyze the Stockholm market. Based on 302 predominantly residential transactions from 1992 to 1994, they find property type, age, and dummy variables for four areas of the city to be significant. Gunnelin et al. (2004)use 599 Swedish valuation reports from 2000 for properties located in Stockholm, Gothenburg, and Malmö to explain differences in the assumptions of appraisers in expected NOI growth, discount rates, and exit cap rates. Higher discount rates are found to be associated with properties that have lower market rents, higher long-run vacancy rates, are in outlying areas, and with buildings that are held as ground leases (as opposed to freeholds). The latter increases the risk since the ground lease form of ownership results in a leveraged payment stream. Netzell(2009) confirms the findings by Gunnelin et al. (2004) by extending the period of observation to 1998–2004, while adding the age of the property as an additional explanatory factor. He also investigates the rationality of Swedish property valuations, i.e. the extent to which appraisals follow the economic theory. He concludes that they do not exhibit major evidence of irrationality.

To summarize, the findings from the micro-level analyses are that age, renovation, size, building class, building type, ground lease, below market financing, ratio of current to market rent, density, and location are important in explaining cap rates. Overall, previous cap rate studies provide evidence that cap rates depend on (1) the capital markets, (2) the perceived risk associated with the investment under consideration, which itself depends on both individual property characteristics and local market conditions, and (3) the investor's expectation about future property value increases, which again depends on both individual property characteristics and local market conditions. By building on this literature, our paper will use variables from all three categories and combine the two streams of research.

3. Method

3.1 Cap Rate Model

On the basis of the simplified conditions of the Gordon model (1962), i.e. a constant expected required rate of return r and a constant expected rate of growth g in the net operating income *NOI*, the price of a property is given by:

$$P = NOI/(r-g). \tag{1}$$

If *NOI* is expressed as a percentage of the rental income α, while the required rate of return is decomposed into risk-free interest rate r_f and risk premium r_p, we have:

$$P = \frac{\alpha RENT}{r_f + r_p - g}. \tag{2}$$

Consequently, the capitalization rate C is given by:

$$C = \frac{\alpha RENT}{P} = r_f + r_p - g. \tag{3}$$

This formula is an approximation, but it contains the main components of the cap rate, is consistent with more detailed present-value models, and therefore motivates our empirical cap rate specification. More precisely, we combine the previous two streams of research that have analyzed either the cap rate variation at the macro-or micro-level, and therefore split both r_p and g from *Equation (3)* into micro and macro contributions. With *LD* representing a vector of location dummies, our empirical specification of *Equation (3)* in the matrix form is therefore:

$$ln(C) = \beta_0 + \beta_1 LD + \beta_2 r_f + \beta_3 r_{p\_macro} + \beta_4 r_{p\_micro} + \beta_5 g_{macro} + \beta_6 g_{micro} + \varepsilon \tag{4}$$

where r_{p_macro} is a vector of variables that capture the overall risk premium required for real estate investments, while r_{p_micro} is a vector of variables that proxy for the risk premium required for individual property risk factors, such as the property's refurbishment risk, its tenant diversification or illiquidity risk. g_{macro} represents the vector of variables that proxy for the expected growth rate in cash flows for the market as a whole and g_{micro} is the vector of variables that measure the difference in g at the property level due to differences in individual property characteristics.

Our sample does not contain information related to either *NOI* or α, but simply to *RENT*. We therefore substitute α *RENT* with *RENT* in *Equation (3)*. This simplification has two consequences. First, the level of the cap rate and thus the intercept of our empirical specification will be increased by $ln(\alpha)$. Second, it will reduce the explanatory power of the empirical specification, as α is not constant, but varies across properties. As reported by IAZI (2011, pp. 129–144), a closer look at operating expenses, i.e. the determinants of α, based on 45,000 annual accounts from 9,000 different properties, reveals two important sources of variation in α: These are the canton in which the property is located and the percentage of income from commercial versus residential tenants. The former is due to the fact that in some Swiss regions, a larger fraction of expenses is outsourced to the tenant than in other regions, which reduces α. The latter is because commercial tenants usually require a lower standard of finish of the interior than residential tenants as they want the interior to be tailored to their specific demands. Hence, a higher percentage of commercial tenants reduces the expenses incurred by the owner and thereby leads to a lower α. We account for these two sources of variation by including nine dummy variables that represent different areas of the country, grouped according to their ZIP codes as well as a property-specific variable that measures the percentage of rents paid by commercial tenants. [1]

3.2 Outliers and Robust Regression

Other important observations with respect to α are that the highest expense items are maintenance and investments, and these exhibit large variations over time, i.e. they are close to zero for most of the time and extremely high whenever the property is being refurbished, i.e. every 20 to 30 years (IAZI, 2011, pp. 127–144). When the time of a refurbishment is unknown, the simplification with respect to α may produce outliers in cap rates. In order to eliminate potential statistical issues related to this, we use robust regression, which ‘protects’ the estimates from possible outliers. Robust regression has a further advantage as it not only protects from outliers caused by an unusual α, but from any outliers, including outlying observations due to data errors (Hoaglin et al., 2000; Rousseeuw & Leroy, 2005; Maronna et al., 2006). Thus, all our results will be based on Huber’s (1981) M-estimator, where the iteratively reweighted residual is estimated by using the median absolute deviation.

3.3 Metrics to Assess the Relative Importance of Cap Rate Determinants

In order to compare the importance of the determinants of appraisal-based and transaction-based cap rates, we use seven different measures of relative importance that have been suggested in the literature. Darlington (1968) gives

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[1] To assess how well our proxy captures the true *NOI*, we use a simple model where the log *NOI* is explained by the log *RENT*, nine location dummies, and the percentage of rents paid by commercial tenants. The calibration of this model on the basis of the data used by IAZI to produce the above mentioned report leads to an R^2 of 0.95. Consistent with expectations, the coefficient of *RENT* is not statistically different from unity, the coefficient of the percentage of rents paid by commercial tenants is positive and the intercept of -0.28 indicates that on average, *NOI* is about 30% lower than *RENT*. All coefficients are highly significant, with a t-value of *RENT* of 660. We conclude that our substitute for *NOI* should proxy well for the true *NOI*.

an overview of the first three metrics used, which are called *First*, *Last* and *Beta2*. The metric *First* compares the relative importance of each regressor by comparing the R^2-values from k regression models, when only one out of all k regressors is present. The metric *Last* compares what each regressor is able to explain in terms of R^2 in addition to all other k-1 regressors. *Beta2* compares the standardized coefficients. It makes use of the fact that if a variable is rescaled from a [0,100] to a [0,1] scale, its coefficient will simply be multiplied by 100. In order to make the coefficients scale-invariant, they are standardized by using their estimated standard deviations, i.e.:

$$\hat{\beta}_{k,standardizes} = \hat{\beta}_k \frac{\sqrt{s_k}}{s_y} \tag{5}$$

where s_k and s_y represent the empirical variance of regressorx_k and response y, respectively. The other four metrics are called *Pratt*, *Genizi*, *CAR* and *AIC*. The *Pratt* metric was first discussed by Hoffman (1960) and then later advocated by Pratt (1987). It is based on the multiplication of the standardized coefficient by the marginal correlation. Since the sum of these two products over all regressors yields the overall R^2, it is a natural decomposition of the R^2. Genizi (1993) argues in favor of a specially constructed orthonormal basis for the space of all regressors, which would reduce to the squared marginal correlations in the case of uncorrelated regressors. Zuber & Strimmer (2011) introduce the correlation-adjusted marginal correlation (*CAR*) score, which is based on the Mahalanobisde correlation of the explanatory variables. Thus, *CAR* scores represent the marginal correlation adjusted for the correlation among explanatory variables. They are related to the *Genizi* measure in that the metric of Genizi can be understood as a weighted average of the squared *CAR* scores. Another well-known metric that shows how good different models fit the same data is the Akaike (1974) information criterion (*AIC*). Our seventh metric therefore uses the approach of the *Last* metric, but assesses the model fit with the *AIC* instead of R^2. Consequently, for our seventh metric, we calculate the percentage improvement in *AIC* when each regressor is added to the model in addition to all other k-1 regressors. For ease of comparison and interpretation, all metrics are rescaled such that the outcome of every metric yields 100 when the sum of all regressors is considered.

4. Data

4.1 Transaction-Based and Appraisal-Based Data Sources

The real estate data are sourced from the IAZI database, which arguably is the largest real estate database in Switzerland. Although this database is not publicly accessible, it has been used for several recent academic contributions (Bourassa et al., 2008, 2010, 2011; Constantinescu, 2010; Chaney & Hoesli, 2010). The IAZI data also form the basis for the construction of hedonic price indices that are published by the Swiss stock exchange (the SIX Swiss

Exchange), and for automated hedonic appraisal models (Scognamiglio, 2000) that are used for mortgage lending purposes.

IAZI collects data on real estate transactions from a wide array of mortgage lenders in Switzerland, which cover roughly 60% of the transactions performed at arm's length. Although the bulk of transactions pertain to the owner-occupied housing market, a few thousand observations are for investment properties (income-producing apartment buildings and office properties). After eliminating all properties for which some data are missing and performing various quality controls to screen data errors, there remain about 3,500 transactions which took place between 1985 and 2010.

In addition to these transaction data, IAZI collects appraisal-based data from major Swiss real estate owners, i.e. institutional investors, such as real estate funds, insurance companies, and pension funds. As these investors need to appraise their properties at least once a year for their balance sheets, the IAZI database contains appraisal-based data for the 1995–2010 period for about 8,700 properties, which corresponds to a market value of approximately CHF 97 bn.

With respect to appraisal methods, the Swiss Valuation Standards, which claim to describe best practices, mention the sales comparison, cost and income capitalization approaches (the latter include the discounted cash-flow (DCF) and the cap rate approaches) as the three preferred valuation methods (RICS Switzerland, 2007, p. 34). A survey by Hersberger (2008, p. 74 and p. 81) shows that in Switzerland, the DCF method is clearly the most prominent valuation approach, followed by the direct capitalization method. The cost and the sales comparison approaches are much less utilized. Thus, whereas it is obvious that transaction-based cap rates are implicit cap rates, this is also true for appraisal-based cap rates which are derived from valuations (performed by mainly using the DCF method).

4.2 Overview of Variables

Both the transaction-based and the appraisal-based data include information about property prices or valuations, rents, and various property-specific variables. Transactions and valuations can potentially take place at any time throughout the calendar year. As the available data includes the reference year (but not the exact date) for every observation, each cap rate record is complemented by the latest end-of-year value for several economic variables that were available at the time of the transaction or valuation: The vacancy rate of the municipality in which the property is located and the growth rate in the GDP of Switzerland are both available from the Swiss Federal Statistical Office;[2] the yields on ten-year Swiss government bonds are published by the

[2] www.bfs.admin.ch.

Swiss National Bank;[3] and the P/E-ratio for the S&P 500 index can be obtained from Shiller(2005).[4] The vacancy rate is available at the community level only back to 1995, wherefore we proxy the evolution for each community for the 1985–1995 period by using the evolution of the national vacancy rate.

In considering locational dummy and property-specific variables that are used to capture the variation in α, we have a total of 30 variables to estimate *Equation (4)*. Several variables have been transformed with a natural logarithm as their distributions were strongly skewed. Summary statistics for each variable are provided in Table 1, while Table 2 presents an overview of all variables by providing their definition, the mapping to the corresponding component of *Equation (4)*, the expected sign of its coefficient, a list of previous cap rate studies that have used the same variables, an indication of whether this variable is available for both samples or the transaction sample only, and the source of the variable. Explanations are warranted with respect to the expected sign and the mapping of each variable to the corresponding component from *Equation (4)*. Those are provided in the following sections.

4.2.1 Proxy for the Evolution of the Macro-Level Risk Premium

Several studies have documented the linkages between real estate cap rates and the stock market (Nourse, 1987; Evans, 1990; Ambrose & Nourse, 1993; Jud & Winkler, 1995; Sivitanidou & Sivitanides, 1999; Chen et al., 2004; Hendershott & MacGregor, 2005b; McDonald & Dermisi, 2009). In line with these studies, we incorporate the *P/E* from the stock market as a potential cap rate determinant. The *P/E* is high whenever a lot of capital is invested into the stock market, leaving more limited capital for the real estate market, thus leading to a high cap rate. As a change in the *P/E* neither affects g, nor r_f or r_{p_micro}, the components of *Equation (4)*indicate that a change in the *P/E* must affect the cap rate through a change in r_{p_macro}. That is, whenever the P/E decreases, money flows out of the stock market and (at least partially) into the real estate market. This renders the real estate market more competitive, thus allowing for lower real estate risk premia (r_{p_macro}) and thereby leading to a compression of the cap rates. We therefore proxy for the evolution of r_{p_macro} with the evolution of the *P/E* for the S&P 500 index.[5]

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[3] www.snb.ch.

[4] The Shiller P/E is defined as the current price to the average inflation-adjusted earnings from the past ten years. The values are available at www.irrationalexuberance.com.

[5] There does not exist a long enough series for the *P/E* for the SMI, which is Switzerland's most important stock market index. However, Switzerland is a small and open economy (Assenmacher-Wesche & Pesaran, 2009). Therefore, Swiss companies are strongly exposed to international market movements. This is particularly true for those companies that are part of the SMI, as all of them generate a significant amount (often even the majority) of their sales abroad. Consequently, any equity index that is important for the world economy might be a useful proxy for the

Table 1 Variable Summary Statistics

Variable	Min	Max	Mean	Std. Dev.	Interpretation
C	0.01	0.38	0.07	0.02	
ln(C)	-4.52	-0.97	-2.73	0.20	
DLeasehold	0.00	1.00	0.01	0.10	1: With Leasehold
DEasement	0.00	1.00	0.10	0.30	1: With Easement
lLandLev	-2.93	4.93	1.89	0.88	
DAuction	0.00	1.00	0.01	0.10	1: Auction
DOther	0.00	1.00	0.24	0.43	1: Other
MaxAppPct	0.00	1.00	0.55	0.21	
MaxAppPct2	0.00	0.31	0.04	0.06	
PctCom	0.00	1.00	0.10	0.22	
lAvgAppSize	0.00	7.05	3.08	1.99	
PropRegRents2	0.00	1.00	0.02	0.14	
lAge	0.00	7.61	3.54	0.85	
DNew	0.00	1.00	0.02	0.15	1: New
RenoY	0.00	1.00	0.46	0.50	1: Renovated
CQ	1.00	4.00	2.84	0.53	1: Bad; 4: Very Good
Cond	1.00	4.00	2.80	0.77	1: Bad; 4: Very Good
lVol	6.74	12.95	9.16	0.92	
lVol2	0.00	14.38	0.85	1.19	
MCH	-0.39	0.64	0.16	0.16	-0.4: Bad; 0.6: Very Good
MIC	1.00	4.00	2.47	0.73	1: Bad; 4: Very Good
lRentAbM	-2.05	2.44	0.01	0.31	
VAC	0.00	0.13	0.01	0.01	
GDP	-1.72	8.45	2.75	2.41	
RF10y	1.85	6.56	2.49	0.68	
SP500PE	10.00	43.77	24.61	5.03	
PLZ1	0.00	1.00	0.26	0.44	
PLZ2	0.00	1.00	0.05	0.21	
PLZ3	0.00	1.00	0.06	0.24	
PLZ4	0.00	1.00	0.13	0.34	
PLZ5	0.00	1.00	0.05	0.22	
PLZ6	0.00	1.00	0.08	0.27	
PLZ7	0.00	1.00	0.01	0.07	
PLZ8	0.00	1.00	0.32	0.47	
PLZ9	0.00	1.00	0.05	0.21	

SMI. This can be seen for example in the high correlation (77%) between the quarterly returns of the SMI and the S&P 500 indices. In addition, Swiss real estate investments compete with both national and international equity investments, especially because Swiss investors do not necessarily invest more in domestic than foreign stocks. The asset allocation of the Pictet LPP 2005 index, which serves as a benchmark for most Swiss pension funds, indicates that these institutions allocate about twice as much assets to international than to domestic stocks. In the absence of a long enough *P/E* series for the SMI, we use the *P/E* for the S&P 500 index without making use of exchange rates. The latter is because we use the S&P 500 index as a proxy for the SMI index due to the high correlation between the two. As such, it does not require any currency conversion. In any case, the *P/E* ratio is the price in USD divided by the earnings in USD, which cancels out the USD measure, thus leaving the *P/E* ratio as a currency independent figure.

Table 2 Overview of Variables

Component of Equation (4)	Name	Definition	Expected Sign	Previously Analyzed by	Availability	Source
micro r_p (ownership leverage)	DLeasehold	Dummy, equals 1 in case of a leasehold	+	GHHS(04), N(09)	transactions	IAZI
	DEasement	Dummy, equals 1 in case of easements	+		transactions	IAZI
micro r_p (land leverage)	lLandLev	Land leverage measured as ln(volume/lot size)	+	HT(99)	both	IAZI
micro r_p (off market)	DAuction	Dummy, equals 1 in case of a forced sale (auction)	+		transactions	IAZI
	DOther	Dummy, equals 1 whenever the transaction was neither an auction nor done at arm's length, i.e. when the sale was e.g. in relation with a related legal entity or to a family member	-		transactions	IAZI
micro r_p (tenant diversification)	MaxAppPct	Represents the property's concentration/diversification in apartment sizes; calculated by dividing the number of apartments of each size by the total number of apartments and then taking the maximum of this ratio	+		transactions	IAZI
	MaxAppPct2	Centered square of MaxAppPct	-		transactions	IAZI
α& micro r_p (tenant diversification & tenant risk)	PctCom	Percentage of rents from commercial tenants	-	HT(99), JSZ(01)	both	IAZI
micro r_p (tenant risk)	lAvgAppSize	A proxy for the average tenant quality (wealthier tenants can afford larger units) defined as ln(residential surface/total number of apartments)	-		both	IAZI
micro r_p (tenant/regulatory risk)	PropRegRents2	The square of the percentage of regulated rents	+		transactions	IAZI

(Continued…)

(Table 2 Continued)

Component of Equation (4)	Name	Definition	Expected Sign	Previously Analyzed by	Availability	Source
micro r_p (refurbishment risk)	lAge	Ln(Age)	+	JSZ(01), MDD(08), MDD(09), SSS(94)	both	IAZI
	DNew	Dummy, equals 1 when the property is new, i.e. not older than two years	-	related to age	both	IAZI
	RenoY	Dummy, equals 1 when the property has been refurbished	+ / -	MDD(08), MDD(09)	both	IAZI
	CQ	Construction quality	-		both	IAZI
	Cond	Condition of the property	-		both	IAZI
micro r_p (illiquidity)	lVol	Ln(volume)	+	SSS(94)	both	IAZI
	lVol2	Centered square of lVol	-		both	IAZI
micro g & micro r_p	MCH	Rating for the macro location	-	AN(93), CCW(10), CHN(04), GHHS(04), HMG(05a), JSZ(01), N(09), SS(96), SS(99), SSTW(01)	both	IAZI
	MIC	Rating for the micro location, i.e. the location within the macro location	-	GHHS(04), HT(99), N(09)	both	IAZI
micro & macro g	lRentAbM	Rent relative to median rent	+ / -	CHN(04), CLN(09), GHHS(04), HMG(05a), HMG(05b), N(09), SSTW(01), SS(99)	both	IAZI
	VAC	Vacancy rate of the community at the beginning of the year during which the transaction/valuation took place	+	CHN(04), GHHS(04), MDD(08), MDD(09), N(09), SS(96)	both	Swiss Federal Statistical Office
macro g	GDP	Growth in nominal GDP at the beginning of the year during which the transaction/valuation took place	+ / -	real gdp: CHN(04), CLN(09) inflation: CHN(04), CLN(09), HMG(05a), SS(99), SSTW(01)	both	Swiss Federal Statistical Office

(Continued…)

(Table 2 Continued)

Component of Equation (4)	**Name**	**Definition**	**Expected Sign**	**Previously Analyzed by**	**Availability**	**Source**
r_f	RF10y	Risk-free interest rate with a maturity of 10 years at the beginning of the year during which the transaction/valuation took place	+	CLN(09), HMG(05a), JW(95), MDD(08), MDD(09), N(09), SSTW(01)	both	Swiss National Bank
macro r_p	SP500PE	Shiller P/E-ratio of the SP500 index at the beginning of the year during which the transaction/valuation took place	+	AN(93), CHN(04), E(90), JW(95), HMG(05b), MDD(09), N(09), SS(99)	both	Shiller (2005)
LD/α	LD1	Location dummy to capture variation in α			both	IAZI
	LD2	Location dummy to capture variation in α			both	IAZI
	LD3	Location dummy to capture variation in α			both	IAZI
	LD4	Location dummy to capture variation in α			both	IAZI
	LD5	Location dummy to capture variation in α			both	IAZI
	LD6	Location dummy to capture variation in α			both	IAZI
	LD7	Location dummy to capture variation in α			both	IAZI
	LD8	Location dummy to capture variation in α			both	IAZI

Note: The abbreviations in the column "previously analyzed by" represent previous cap rate studies that used one or several of the above variables. The abbreviations are always of the form: first letter of each author plus, in brackets, the year of the publication.

4.2.2 Proxies for Micro-Level Risk Premia

A total of 15 property-specific variables that could all potentially affect r_{p_micro} were identified (Table 2). The first two subcategories of these micro-level risks include three variables with respect to leverage risk. A high land leverage implies that even with a small lot size, a high rent can be earned. Stated differently, a high land leverage indicates that a significant amount of the rental income of the investor is exposed to the attractiveness of one particular location. An important source of volatility in prices (and rents) is the evolution of the attractiveness of land (Bostic et al., 2007; Davis & Heathcote, 2007; Bourassa et al., 2009, 2011; Nichols et al., 2013). As the investor's exposure to the location risk factor is high whenever the land leverage is high, a higher risk premium is expected. In the case of an existing leasehold or easements, a higher risk premium is expected too, as any investment over which one does not have full control usually goes along with higher perceived risk.

Another subcategory is related to the tenants. We expect to find a lower r_{p_micro} for properties with good tenants, which we measure by the average apartment size (wealthier tenants can afford larger units) and the percentage of rents from commercial versus residential space. In addition, a high percentage of regulated rents and a low diversification of tenants increase the risk and therefore might both lead to a higher r_{p_micro}. As tenant diversification is not directly observable with the data at hand, we calculate the concentration in apartment sizes for each property by dividing the number of apartments with a specific number of rooms by the total number of apartments. The maximum of this percentage over all room categories represents the concentration in a specific apartment category. Therefore, a building with a low maximum apartment percentage would have many different apartment sizes, thereby attracting different kinds of tenants, thus having a well diversified tenant risk, which we would expect to reduce r_{p_micro}.

A third subcategory is illiquidity risk. Larger properties, as measured by their volume, are more expensive. As more expensive properties can be afforded by fewer investors, their potential demand is lower, which suggests a positive coefficient. We also include the squared value of the volume variable to capture potential nonlinearities.

While the dependence of the cap rates on property-specific variables discussed above has rarely and for some variables never been analyzed in previous studies (for details, seeTable 2), the last subcategory, i.e. refurbishment risk, has already been well researched in the cap rate literature. Refurbishment risk refers to the fact that refurbishments significantly influence a property's cash flow, but that both the exact time of the refurbishment and the required expenses to actually undertake the refurbishments are uncertain. To capture this source of risk, we include age, construction quality, building condition, a dummy variable for new properties, and an additional dummy variable that indicateswhether the property has or has not already been refurbished. While the expected signs for age, building condition, construction quality, and the dummy for the new building are straightforward, the refurbishment dummy could have either sign. On the one hand, a renovated property might be considered as having a defect, similar to a repaired car, thus requiring a higher cap rate. On the other hand, as we are unaware of the date of the last refurbishment, the cap rate could also be lower, if the property had been *recently* refurbished, as this would reduce the refurbishment risk for the near future.

4.2.3 Proxies for the Risk-Free Rate and the Micro- and Macro-Level Growth Rates

The remaining components of *Equation (4)* are the expected micro and macro growth rates and r_f. We use the yield on Swiss government bonds with a maturity of ten years as the risk-free rate. A maturity of ten years was selected to be in line with the long-term nature of real estate investments.

Rent, GDP, inflation, and vacancy rates are variables that have a theoretical justification for being considered as growth proxies. We therefore use the nominal growth in GDP to proxy for g_{macro}, thereby capturing expected real estate market-wide growth in *NOI* due to both general inflation and real economic growth. As GDPis mean-reverting, a rational market participant would anticipate low future g_{macro} whenever current GDP is high, while a myopic market participant might simply extrapolate past GDP, thus expecting high future g_{macro}. Consequently, the GDPcan have either sign, depending on the rationality of the market participants. The vacancy rateof the community and the rent level of the property relative to median rent both vary across properties and over time because of cross-sectional variations and general market evolutions, respectively. Therefore, they capture variations in both micro and macro g. The expected sign of the vacancy rateis positive, as a high vacancy rate in the community of the property strongly limits the rental growth potential of this property, thus leading to a higher cap rate. Similar to the GDP, the sign of the rent level of property relative to the median rent depends on the rationality of the market participants. A myopic individual would believe that rents will continue to increase for properties that already have an above average rental level, while a rational individual would consider that the upside potential is strongly limited whenever the rent is already much above the average level.

4.2.4 Variables for Location

We consider two variables to assess the attractiveness of a property's location. Thus, both variables capture variations in g_{micro} and r_{p_micro}. The quality of an area as a whole, i.e. the macro location (*MCH*), is measured by an index as defined by Scognamiglio (2000) that rates every ZIP code based on about 50 characteristics derived from tax and income statistics, population density and distribution, infrastructure statistics, and other local and geographical factors. The quality of the location within that area (*MIC*) represents a qualitative assessment by the owner or appraiser of the building.

5. Empirical Results

The discussion of the results is organized as follows. First, we analyze the full transaction-based sample and focus on the coefficients and relative importance of each variable. This will help to gain a better understanding of the transaction-based cap rate determinants and enable comments on the importance of the newly introduced variables, i.e. variables that were not considered in previous cap rate studies. Thereafter, the period of analysis will be shortened to 1995–2010 as appraisal-based data are not available prior to 1995. We then briefly compare the results of the transaction-based data for the full period with those of the shortened period, as this will make it possible to gauge the model's stability across different time windows. Next, we proceed to compare the importance of cap rate determinants for investors (transaction-based data) and appraisers (valuation-based data), respectively, thereby adding to the understanding of the similarities and differences in the risk perception and pricing of investors and appraisers. Finally, we discuss the results of our robustness checks.

5.1 Full Transaction-Based Sample

For the full transaction-based sample, we have a total of 30 variables to estimate *Equation (4)*. Table 3 provides the estimation results for two slightly alternative model specifications. The first, entitled 'Economic Variables', is the estimation of *Equation (4)* with all variables as listed in Table 2. The second differs with respect to how the evolution of the cap rate is accounted for. While the first model captures this evolution through the evolution of the economic variables that only vary over time but not by property (i.e., *GDP*, *RF10y* and *SP500PE*), the second model uses time dummies rather than those variables.

All significant coefficients appear with the expected sign. In addition, the coefficients and significance are very similar for both specifications, which indicates that both approaches work equally well for analyzing the determinants of property-specific cap rates. As the error terms will not necessarily fulfill the standard assumptions required for inference, we use Newey & West's (1987) heteroskedasticity and autocorrelation-consistent estimates.

The data section revealed that the expected sign was not clear a priori for three variables. With respect to these three variables, we find that a property that has previously been renovated is associated with a significantly lower refurbishment risk, thus leading to a 2% lower cap rate. With respect to investor rationality, the results are mixed as investors seem to act rationally in the case of the property's rent level relative to median rent, but myopically with respect to GDP.

Table 3 Full Transaction-Based Model

Variable	Economic Variables				Time Dummies			
	Coef.	*Std. Error*	*HAC z*	*Pr(>|z|)*	*Coef.*	*Std. Error*	*HAC z*	*Pr(>|z|)*
(Intercept)	-2.825	0.058	-48.37	0.0%	-2.860	0.058	-49.42	0.0%
DLeasehold	0.137	0.031	4.35	0.0%	0.126	0.031	4.05	0.0%
DAuction	0.098	0.040	2.47	1.4%	0.084	0.034	2.45	1.4%
DOther	-0.032	0.007	-4.92	0.0%	-0.022	0.007	-3.44	0.1%
MaxAppPct	0.043	0.015	2.95	0.3%	0.054	0.014	3.75	0.0%
MaxAppPct2	-0.196	0.048	-4.05	0.0%	-0.222	0.047	-4.70	0.0%
DEasement	0.018	0.009	1.97	4.9%	0.023	0.009	2.60	0.9%
PropRegRents2	0.116	0.061	1.90	5.7%	0.115	0.051	2.23	2.6%
lAge	0.063	0.005	12.47	0.0%	0.074	0.005	14.84	0.0%
DNew	0.008	0.016	0.50	61.6%	0.012	0.016	0.77	43.9%
RenoY	-0.017	0.007	-2.39	1.7%	-0.023	0.007	-3.36	0.1%
CQ	-0.034	0.006	-5.32	0.0%	-0.036	0.006	-5.79	0.0%
Cond	-0.047	0.006	-8.16	0.0%	-0.039	0.006	-7.04	0.0%
lLandLev	0.038	0.005	8.02	0.0%	0.036	0.005	7.76	0.0%
lVol	0.018	0.005	3.55	0.0%	0.025	0.005	5.05	0.0%
lVol2	-0.023	0.003	-7.17	0.0%	-0.023	0.003	-7.23	0.0%
PctCom	-0.054	0.027	-1.98	4.8%	-0.034	0.027	-1.25	21.3%
lAvgAppSize	-0.023	0.005	-4.83	0.0%	-0.022	0.005	-4.73	0.0%
MIC	-0.039	0.005	-7.93	0.0%	-0.038	0.005	-7.68	0.0%
MCH	-0.404	0.026	-15.46	0.0%	-0.495	0.026	-18.81	0.0%
lRentAbM	0.244	0.015	15.97	0.0%	0.281	0.015	18.44	0.0%
VAC	0.695	0.242	2.87	0.4%	0.588	0.242	2.43	1.5%
PLZ1	0.057	0.010	5.93	0.0%	0.049	0.009	5.30	0.0%
PLZ2	0.035	0.014	2.46	1.4%	0.037	0.014	2.64	0.8%
PLZ3	-0.003	0.010	-0.33	74.5%	0.004	0.010	0.37	70.9%
PLZ4	-0.006	0.009	-0.68	49.4%	-0.001	0.008	-0.13	89.4%
PLZ5	0.014	0.010	1.34	18.1%	0.013	0.010	1.25	21.0%
PLZ6	-0.021	0.010	-2.17	3.0%	-0.013	0.009	-1.38	16.8%
PLZ7	-0.058	0.028	-2.06	3.9%	-0.057	0.029	-1.99	4.6%
PLZ9	0.030	0.010	2.91	0.4%	0.030	0.010	2.99	0.3%
RF10y	0.053	0.004	13.89	0.0%				
SP500PE	0.003	0.000	7.54	0.0%				
GDP	-0.003	0.001	-2.48	1.3%				
D2009					0.032	0.012	2.58	1.0%
D2008					0.083	0.013	6.62	0.0%
D2007					0.104	0.013	8.29	0.0%
D2006					0.100	0.013	7.46	0.0%
D2005					0.111	0.012	9.18	0.0%
D2004					0.167	0.013	12.82	0.0%
D2003					0.168	0.013	12.56	0.0%
D2002					0.176	0.015	11.73	0.0%
D2001					0.127	0.016	8.02	0.0%
D2000					0.214	0.021	10.36	0.0%
D1999					0.192	0.018	10.88	0.0%
D1998					0.254	0.018	14.31	0.0%
D1997					0.258	0.020	13.05	0.0%
D1996					0.214	0.021	10.03	0.0%

(Continued…)

(Table 3 Continued)

Variable	**Economic Variables**				**Time Dummies**			
	Coef.	*Std. Error*	*HAC z*	*Pr(>|z|)*	*Coef.*	*Std. Error*	*HAC z*	*Pr(>|z|)*
D1995					0.214	0.026	8.34	0.0%
D1994					0.152	0.018	8.29	0.0%
D1993					0.173	0.025	6.91	0.0%
D1992					0.276	0.041	6.75	0.0%
D1991					0.396	0.043	9.15	0.0%
D1990					0.729	0.044	16.47	0.0%
D1989					0.280	0.055	5.05	0.0%
D1988					0.156	0.035	4.41	0.0%
D1987					0.267	0.026	10.32	0.0%
D1986					0.269	0.024	11.43	0.0%
D1985					0.215	0.026	8.41	0.0%
wR2				46.4%				51.3%
Stdev. Error				0.1499				0.1464
Df				3464				3442

Note: Heteroskedasticity and autocorrelation-consistent z-values are presented in the column "HAC z". They are based on Newey and West (1987). WR2 represents the weighted R2, which corresponds to the traditional R2 with the difference that the observations are weighted with the weight from the robust regression, i.e.

$$wR2 = 1 - \left[1/n \sum w\left(\mu - \bar{\mu}\right)^2\right] \Big/ \left[1/n \sum w\left(y - \bar{y}\right)^2\right]$$

To the best of our knowledge, this study is the first that uses easements, auctions, off-market transactions, proportion of regulated rents, construction quality, building condition, tenant quality, and tenant diversification to explain cap rates. With respect to these variables, the results show that if the property is not purchased at arm's length but at an auction, a 9% higher return can be achieved. We believe this to be due to the fact that selling a property at an auction implies fewer potential buyers compared to a regular selling process, which lowers the sale price, thus allowing for a higher return. When a property is sold off the market, e.g. to a related legal entity or to a family member (*DOther*), the cap rate is reduced on average by 3%, while a property with easements trades at a 2% higher cap rate. The construction quality, building condition and average apartment size variables have the potential to change the cap rate by 14%, 10%, and 7%, respectively. To illustrate the nonlinear effect of tenant diversification (*MaxAppPct* and *MaxAppPct2),* note that a property with good diversification (*MaxAppPct* of 20%) has a cap rate that is 1.6% lower than a property with slightly worse diversification (*MaxAppPct* of 30%), and a 3.8% lower cap rate than a property with really bad diversification (*MaxAppPct* of 80%). By analyzing the results for the seven metrics of relative importance (Table 4), it becomes clear that of all the variables that were not considered in previous research, building condition and construction quality are the most important. On average, they have a relative importance of 9% and 6%, respectively, which corresponds to the third and sixth most important variables.[6] Altogether, the effects of the nine variables that have not been investigated in the prior literature explain 10 percentage points, i.e. 22%, of the R^2 of 46%.[7]

Table 4 Relative Importance of Variables for the Full Transaction-Based Sample

Variable	Relative Importance for Each Individual Variable							
	Last	*First*	*Beta2*	*Pratt*	*Genizi*	*Car*	*AIC*	*Average*
DEasement	0.3%	0.2%	0.1%	-0.3%	0.1%	0.0%	0.1%	0.1%
PropRegRents2	0.2%	0.1%	0.1%	0.2%	0.2%	0.2%	0.1%	0.1%
PctCom	0.3%	0.8%	0.3%	-0.7%	0.7%	0.0%	0.2%	0.2%
MaxAppPct	0.5%	0.8%	0.4%	-0.9%	0.2%	0.1%	0.4%	0.2%
GDP	0.5%	0.5%	0.3%	0.6%	0.5%	0.3%	0.4%	0.4%
RenoY	0.4%	2.6%	0.3%	-1.4%	2.2%	0.7%	0.3%	0.7%
DLeasehold	1.7%	0.1%	0.8%	0.4%	0.5%	0.5%	1.6%	0.8%
MaxAppPct2	0.9%	0.7%	0.7%	1.1%	0.9%	1.0%	0.9%	0.9%
VAC	0.6%	1.5%	0.3%	1.1%	1.3%	1.3%	0.5%	0.9%
DAuction	0.9%	1.3%	0.4%	1.2%	1.3%	1.3%	0.8%	1.0%
lVol	0.9%	3.1%	1.0%	2.8%	3.2%	2.2%	0.8%	2.0%
DOther	1.6%	4.1%	0.8%	3.0%	2.8%	2.7%	1.6%	2.4%
lAvgAppSize	1.7%	5.2%	1.3%	4.2%	4.0%	4.4%	1.6%	3.2%
DNew	0.0%	11.4%	0.0%	-0.9%	8.6%	6.6%	-0.1%	3.7%
SP500PE	4.6%	3.9%	2.3%	4.9%	4.4%	4.4%	4.7%	4.2%
MIC	4.4%	6.3%	2.5%	6.4%	6.0%	5.8%	4.5%	5.2%
lVol2	3.7%	6.3%	3.3%	7.3%	6.1%	6.7%	3.7%	5.3%
lLandLev	4.4%	7.6%	3.4%	8.2%	6.6%	7.0%	4.5%	6.0%
CQ	2.0%	12.4%	1.8%	7.5%	8.5%	8.2%	2.0%	6.0%
MCH	15.4%	0.0%	16.1%	-1.2%	3.2%	3.0%	15.6%	7.5%
Cond	4.2%	14.6%	4.0%	12.3%	10.8%	11.4%	4.3%	8.8%
lRentAbM	17.7%	0.0%	16.6%	1.3%	4.1%	4.0%	17.9%	8.8%
RF10y	22.0%	4.3%	12.9%	11.9%	11.0%	11.2%	22.0%	13.6%
lAge	11.3%	12.3%	30.3%	31.0%	12.7%	17.1%	11.5%	18.0%

Note: The relative importance metrics are based on Pratt (1987), Genizi (1993), Zuber & Strimmer (2011), Darlington (1968) and Akaike (1974).

In addition to these nine new variables, we also included several property-specific characteristics that have rarely been used in previous cap rate studies. These are variables that proxy for the illiquidity risk, i.e. project size

[6] Table 2 lists 22 variables plus 8 location dummies, i.e. a total of 30 variables. As discussed in the methodology section, the eight location dummies do not reflect a component of the cap rate (i.e. r_f, r_p or g) but are required to control for potential influences due to the simplification with respect to $\alpha RENT$. When determining the relative importance of each of the 22 variables, we therefore use the location dummies as control variables. This implies that the location dummies always receive a weight of 0 and that the sum over the remaining 22 variables will always add up to 100% for each of the seven metrics of relative importance.

[7] Note that simply taking the sum over individual variables does not exactly lead to the importance of a group of variables. This is because variables are not perfectly orthogonal and only the *Last*, *First* and *AIC* metrics can be used to determine the importance of groups of variables (see the next section).

(Saderion et al., 1994), ownership leverage, i.e. freehold vs. leasehold (Gunnelin et al., 2004; Netzell, 2009) and land leverage, i.e. rentable space to lot size (Hendershott & Turner, 1999). The results show that land leverage and illiquidity risk are both important for explaining cap rates as their relative importance is 6% and 8%, respectively. Ownership leverage, on the other hand, although highly significant, is less important as it contributes only 1% to the explanation of the variation in cap rates.

5.2 Transaction-Based vs. Appraisal-Based Cap Rates

In order to compare the determinants of valuation-based and transaction-based cap rates, we focus on the intersection of the two data sources, i.e. on the 1995–2010 time period and on 24 instead of 30 variables. Before we proceed in making this comparison, we briefly investigate the stability of our previous findings when both the sample period and the number of explanatory variables are reduced. We therefore compare the estimated models from the previous section (Table 3) with the corresponding results of Table 6, which are based on the shorter sample period. For ease of comparison, we present the results side by side in Table 5.

Table 5 Transaction-Based Results for Two Sample Periods

	Economic Variables				**Time Dummies**			
	Full Sample		Joint Sample		Full Sample		Joint Sample	
Variable	*Coef.*	*HAC z*	*Coef.*	*HAC z*	*Coef.*	*HAC z*	*Coef.*	*HAC z*
(Intercept)	2.825	-48.367	-2.852	-43.286	-2.860	-49.421	-2.830	-46.375
DLeasehold	0.137	4.348			0.126	4.055		
DAuction	0.098	2.470			0.084	2.453		
DOther	-0.032	-4.918			-0.022	-3.436		
MaxAppPct	0.043	2.953			0.054	3.747		
MaxAppPct2	-0.196	-4.053			-0.222	-4.700		
DEasement	0.018	1.968			0.023	2.601		
PropRegRents2	0.116	1.900			0.115	2.226		
lAge	0.063	12.472	0.064	11.208	0.074	14.836	0.070	12.748
DNew	0.008	0.501	0.016	0.856	0.012	0.774	0.021	1.155
RenoY	-0.017	-2.390	-0.018	-2.399	-0.023	-3.360	-0.022	-2.996
CQ	-0.034	-5.320	-0.028	-4.096	-0.036	-5.789	-0.029	-4.515
Cond	-0.047	-8.157	-0.046	-7.109	-0.039	-7.039	-0.041	-6.903
lLandLev	0.038	8.024	0.041	8.103	0.036	7.764	0.041	8.252
lVol	0.018	3.551	0.022	3.844	0.025	5.045	0.028	5.275
lVol2	-0.023	-7.169	-0.023	-6.267	-0.023	-7.231	-0.023	-6.738
PctCom	-0.054	-1.977	-0.068	-2.300	-0.034	-1.246	-0.044	-1.492
lAvgAppSize	-0.023	-4.828	-0.027	-5.142	-0.022	-4.734	-0.027	-5.288
MIC	-0.039	-7.926	-0.047	-8.973	-0.038	-7.676	-0.045	-9.034
MCH	-0.404	-15.461	-0.425	-15.422	-0.495	-18.808	-0.493	-17.987
lRentAbM	0.244	15.971	0.248	14.969	0.281	18.444	0.269	16.697
VAC	0.695	2.871	0.972	3.804	0.588	2.430	0.870	3.436
PLZ1	0.057	5.929	0.054	5.000	0.049	5.297	0.051	4.955
PLZ2	0.035	2.458	0.053	3.665	0.037	2.639	0.054	3.733
PLZ3	-0.003	-0.326	0.004	0.346	0.004	0.374	0.010	0.947
PLZ4	-0.006	-0.683	-0.004	-0.417	-0.001	-0.133	0.000	0.015
PLZ5	0.014	1.337	0.002	0.229	0.013	1.254	0.004	0.406

(Continued…)

(Table 5 Continued)

	Economic Variables				Time Dummies			
	Full Sample		Joint Sample		Full Sample		Joint Sample	
Variable	*Coef.*	*HAC z*	*Coef.*	*HAC z*	*Coef.*	*HAC z*	*Coef.*	*HAC z*
PLZ6	-0.021	-2.166	-0.024	-2.427	-0.013	-1.378	-0.016	-1.705
PLZ7	-0.058	-2.061	-0.052	-1.847	-0.057	-1.993	-0.040	-1.376
PLZ9	0.030	2.906	0.035	3.280	0.030	2.987	0.034	3.274
RF10y	0.053	13.894	0.047	8.924				
SP500PE	0.003	7.537	0.005	7.396				
GDP	-0.003	-2.476	-0.006	-4.282				
D2009					0.032	2.585	0.033	2.751
D2008					0.083	6.616	0.086	7.043
D2007					0.104	8.285	0.104	8.461
D2006					0.100	7.464	0.103	7.809
D2005					0.111	9.176	0.114	9.767
D2004					0.167	12.816	0.171	13.681
D2003					0.168	12.559	0.173	13.311
D2002					0.176	11.729	0.177	12.571
D2001					0.127	8.018	0.128	7.561
D2000					0.214	10.356	0.197	7.427
D1999					0.192	10.882	0.188	7.403
D1998					0.254	14.315	0.250	12.585
D1997					0.258	13.051	0.274	12.995
D1996					0.214	10.026	0.217	10.694
D1995					0.214	8.342	0.210	7.748
WR2		46.3%		46.4%		51.3%		50.8%
Stdev. Error		0.150		0.150		0.146		0.139

Note: Heteroskedasticity and autocorrelation-consistent z-values are presented in the column "HAC z". They are based on Newey and West (1987). WR2 represents the weighted R2, which corresponds to the traditional R2 with the difference that the observations are weighted with the weight from the robust regression, i.e.

$$wR2 = 1 - \left[1/n \sum w\left(\mu - \bar{\mu}\right)^2\right] \Big/ \left[1/n \sum w\left(y - \bar{y}\right)^2\right]$$

The results are extremely stable, with the only two exceptions being the vacancy rate and GDP. Their coefficients are still significant, but roughly 30% and 50% lower for the full sample than for the joint sample. The two changes can be explained as follows. GDP and the percentage of auctions per year are negatively correlated because more forced sales are observed during recessions than during boom periods. As the auction dummy is only available for the full sample, the GDP variable captures part of the auction effect in the joint sample. The change in the vacancy coefficient is due to the fact that vacancy rates are available at the community level back to 1995, but only at the national level before that time. This renders the measure of vacancy less precise for the longer time period, which reduces both the significance levels and the sensitivity of the cap rates to this variable.

We further apply two filters to maximize the level of comparability across the transaction-based and appraisal-based data. For those properties for which we use appraised values, a history of five years is available on average, while transacted properties are only observed once (at the time of their transaction). We therefore take a random subsample of the valuation-based sample, such that each appraised property is taken into consideration only once too. In addition, we ensure that for each year, the same number of observations is used for the model calibrations for both the transaction-based and the appraisal-based samples. This leaves a total of 2,858 observations for each of the two data sources and implies that 341 properties from the transaction-based sample and 599 properties from the appraisal-based sample are discarded. In order to base our results on as many observations as possible while maintaining the comparability between the two data sources, we perform this random sampling procedure 250 times and report results as the average of the 250 samples.

We start by calibrating *Equation (4)*with all jointly available variables for the transaction-based data and thereafter for the appraisal-based data. In doing so, we follow the idea of Netzell (2009) and calibrate for both data samples another two versions of *Equation (4)*, i.e. a lower and an upper benchmark model, by slightly adjusting the model with respect to how to consider the evolution of cap rates over time. For the lower benchmark version, we simply eliminate all economic variables that vary over time but not across properties (*GDP*, *RF10y* and *SP500PE*), therefore ignoring most of the evolution of cap rates over time. The upper benchmark is derived by fully accounting for the evolution of cap rates over time, which is achieved by adding yearly time dummy variables to the second model. This leads to a total of three models, each of them calibrated once on the transaction-based data and once on the appraisal-based data. The results are presented in Table 6.

The coefficients as well as their significance are stable when the three models are compared for a given type of data (transactions or appraisals). This shows that the estimation of the property-specific cap rate determinants is unaffected by how time is accounted for. However, a comparison *across* the two types of data reveals that for many variables, the coefficients and their significance differ strongly. This constitutes evidence that appraisers and investors diverge in how they price real estate risk and thus how they finally determine the price of a property. The most obvious differences are that (1) the renovation dummy and the average apartment size are both strongly significant for both market participants, but with opposite signs; (2) the volume, percentage of commercial tenants, and vacancy and risk-free rates are significant with the expected sign for investors, but insignificant for appraisers; (3) rent relative to median rent, micro location, land leverage, and age are all significant with the expected signs, but the significance is much lower for appraisers; (4) the dummy for new buildings is significant with the expected sign for appraisers but insignificant for investors; and (5) building condition is much more significant for appraisers. The only three variables that seem to play a similar role in the pricing mechanism for both investors and appraisers are macro location, GDP, and P/E.

Table 6 Three Alternative Specifications for Transaction-Based and Appraisal-Based Cap Rates

	Transaction-based						Appraisal-based					
	Economic		Without Time		Time Dummies		Economic		Without Time		Time Dummies	
Variable	*Coef.*	*HAC z*	*Coef.*	*HAC z*	*Coef.*	*HAC z*	*Coef.*	*HAC z*	*Coef.*	*HAC z*	*Coef.*	*HAC z*
(Intercept)	-2.852	-43.286	-2.662	-43.052	-2.830	-46.375	-2.672	-50.464	-2.591	-51.522	-2.673	-55.554
lAge	0.064	11.208	0.048	8.074	0.070	12.748	0.017	3.808	0.015	3.315	0.017	3.880
DNew	0.016	0.856	-0.012	-0.638	0.021	1.155	-0.146	-4.592	-0.158	-5.084	-0.123	-3.845
RenoY	-0.018	-2.399	-0.011	-1.378	-0.022	-2.996	0.037	5.742	0.045	6.896	0.040	6.278
CQ	-0.028	-4.096	-0.029	-4.047	-0.029	-4.515	-0.032	-5.220	-0.035	-5.617	-0.029	-4.965
Cond	-0.046	-7.109	-0.055	-8.240	-0.041	-6.903	-0.043	-11.512	-0.045	-11.698	-0.039	-10.345
lLandLev	0.041	8.103	0.044	8.424	0.041	8.252	0.025	5.416	0.026	5.672	0.019	4.228
lVol	0.022	3.844	0.034	6.588	0.028	5.275	0.002	0.444	0.003	0.768	-0.001	-0.218
lVol2	-0.023	-6.267	-0.017	-5.122	-0.023	-6.738	-0.003	-1.237	-0.004	-1.425	-0.003	-0.997
PctCom	-0.068	-2.300	-0.075	-2.454	-0.044	-1.492	0.012	0.917	0.010	0.712	0.017	1.285
lAvgAppSize	-0.027	-5.142	-0.025	-4.359	-0.027	-5.288	0.007	3.555	0.007	3.304	0.007	3.660
MIC	-0.047	-8.973	-0.053	-9.829	-0.045	-9.034	-0.026	-6.232	-0.026	-6.236	-0.021	-4.897
MCH	-0.425	-15.422	-0.346	-12.025	-0.493	-17.987	-0.352	-14.407	-0.372	-15.533	-0.319	-12.773
lRentAbM	0.248	14.969	0.223	13.275	0.269	16.697	0.043	4.088	0.041	3.920	0.035	3.357
VAC	0.972	3.804	1.339	5.063	0.870	3.436	-0.510	-1.662	-0.441	-1.429	0.018	0.059
PLZ1	0.054	5.000	0.071	6.082	0.051	4.955	0.079	9.794	0.075	9.291	0.081	10.334
PLZ2	0.053	3.665	0.058	3.752	0.054	3.733	0.041	2.888	0.039	2.686	0.047	3.439
PLZ3	0.004	0.346	0.007	0.668	0.010	0.947	0.025	1.955	0.019	1.489	0.022	1.793
PLZ4	-0.004	-0.417	-0.002	-0.181	0.000	0.015	0.032	3.867	0.024	2.928	0.028	3.570
PLZ5	0.002	0.229	0.002	0.196	0.004	0.406	-0.012	-0.892	-0.018	-1.258	-0.011	-0.794
PLZ6	-0.024	-2.427	-0.021	-2.066	-0.016	-1.705	0.011	1.040	0.008	0.769	0.005	0.519
PLZ7	-0.052	-1.847	-0.066	-2.413	-0.040	-1.376	0.023	0.741	0.019	0.597	0.022	0.663
PLZ9	0.035	3.280	0.036	3.174	0.034	3.274	-0.002	-0.156	-0.011	-0.758	-0.001	-0.089
RF10y	0.047	8.924					-0.006	-1.218				
SP500PE	0.005	7.396					0.004	6.868				
GDP	-0.006	-4.282					-0.004	-3.514				
D2009					0.033	2.751					0.032	3.028
D2008					0.086	7.043					0.043	4.118

(Continued…)

(Table 6 Continued)

	Transaction-based						Appraisal-based					
	Economic		Without Time		Time Dummies		Economic		Without Time		Time Dummies	
Variable	*Coef.*	*HAC z*	*Coef.*	*HAC z*	*Coef.*	*HAC z*	*Coef.*	*HAC z*	*Coef.*	*HAC z*	*Coef.*	*HAC z*
D2007					0.104	8.461					0.025	2.191
D2006					0.103	7.809					0.046	3.906
D2005					0.114	9.767					0.073	6.980
D2004					0.171	13.681					0.120	10.383
D2003					0.173	13.311					0.107	9.054
D2002					0.177	12.571					0.128	9.712
D2001					0.128	7.561					0.083	5.311
D2000					0.197	7.427					0.043	1.595
D1999					0.188	7.403					0.091	3.570
D1998					0.250	12.585					0.095	4.456
D1997					0.274	12.995					0.116	5.839
D1996					0.217	10.694					0.055	2.645
D1995					0.210	7.748					-0.089	-4.072
WR2		46.6%		40.4%		50.8%		35.0%		33.1%		40.2%
Stdev. Error		0.1445		0.1532		0.1388		0.1325		0.1353		0.1279
Df		2832		2835		2820		2832		2835		2820
Gap Close												
WR2						59.0%						26.3%
Stdev. Error						60.7%						37.3%

Note: The figures for the "gap close" are calculated as $(X_{\text{Economic}}-X_{\text{Without Time}})/(X_{\text{Time Dummy}}-X_{\text{Without Time}})$, where X represents the statistic of interest of the corresponding model X,e.g. (46.6-40.4)/(50.8-40.4)=59.0 for the wR2 of the transaction-based sample. Heteroskedasticity and autocorrelation-consistent z-values are presented in the column "HAC z". They are based on Newey and West (1987). To make similarities and differences more transparent, we used colors that show the sign of the coefficient (green = positive, red= negative) and its significance (highest significance within one model = highest intensity of the color).

WR2 represents the weighted R2, which corresponds to the traditional R^2 with the difference that the observations are weighted with the weight from the robust regression, i.e.

$$wR2 = 1 - \left[1/n \sum w\left(\mu - \bar{\mu}\right)^2\right] \Big/ \left[1/n \sum w\left(y - \bar{y}\right)^2\right]$$

The difference in both R^2 and standard deviation of the residuals between the model without time and that with full time consideration is much larger for investors than appraisers. This observation indicates that transaction-based cap rates vary more over time than appraisal-based cap rates and is consistent with appraisal-smoothing. A related observation is that the economic variables that were used in previous appraisal-based cap rate research do indeed help in narrowing the gap between the lower and upper benchmarks for the appraisal-based data, but that this gap can be narrowed even further for the transaction-based data. More specifically, the gap between zero and full time consideration (‘without time’ vs. ‘time dummy’ model specifications) can be reduced by 60% with the ‘economic’ model specification for the transaction-based data, while it can be lowered by just 30% for the appraisal-based data. Thus, investors seem to be more concerned with changes in economic variables than is the case of appraisers. This conclusion is in line with the fact that all economic variables are more significant in the economic model specification for investors than in the corresponding specification for appraisers.

Motivated by these preliminary findings, we now dig deeper and apply a more rigorous approach to compare the relative importance of each variable across the two categories of data and therefore focus on the seven metrics discussed earlier. The results are reported in Figure 2 and Table 7. Notable differences in the relative importance of the various variables between appraisers and investors exist and this observation remains valid across the seven metrics. The most pronounced differences are that macro location and building condition are much more important for appraisers, while age, rent to median rent, risk-free rate, and volume are much more important for investors across all metrics (all but one metric for rent to median rent). Still revealing differences in the pricing mechanism, although to a lesser degree, appraisers also overweight the renovation dummy, P/E, construction quality and micro location, whereas investors place more emphasis on land leverage, average apartment size and vacancy rates. The dummy for new buildings, the percentage of commercial rents and GDP are equally important for investors and appraisers. Overall, these findings are consistent with our initial observations and provide strong evidence that appraisers and investors focus on different variables when determining cap rates and thus the price of a property.

Figure 2 Importance of Variables for Investors vs. Appraisers

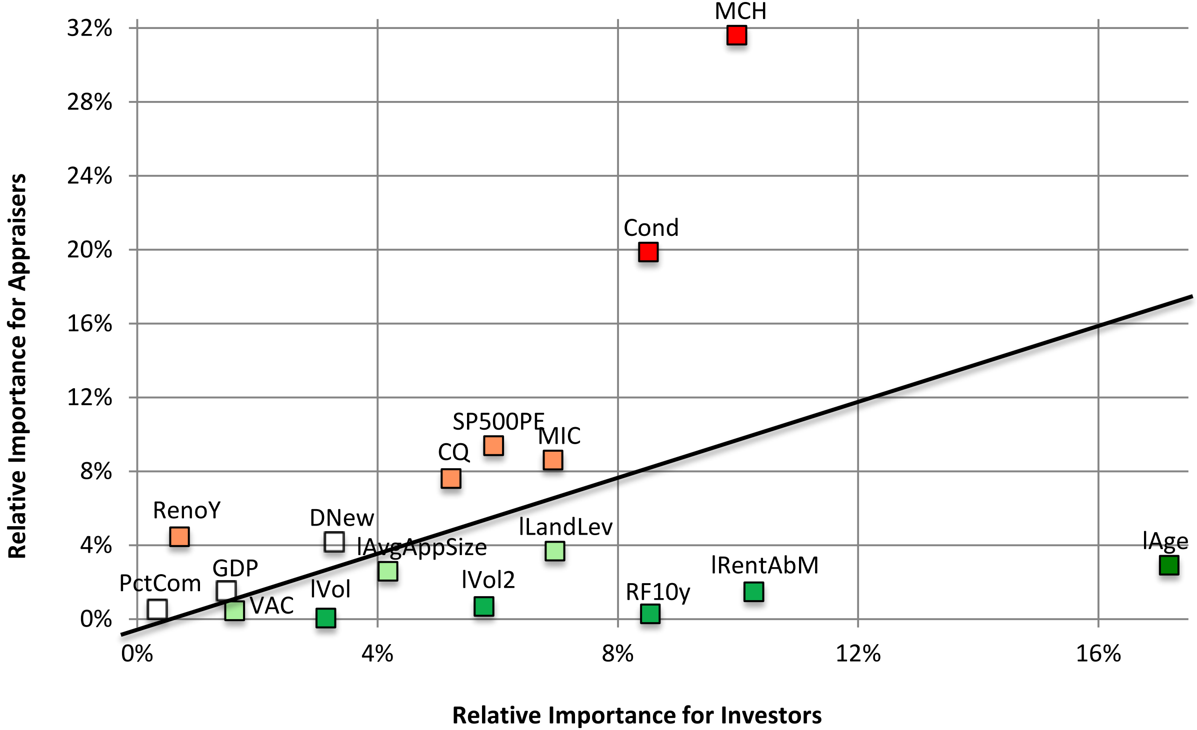


Table 7 Relative Importance of Variables for Investors and Appraisers

Variable	Relative Importance for Investors							Relative Importance for Appraisers							Importance Investors - Appraisers							
Name	Pratt	Gen	Car	Beta2	Last	First	AIC	Pratt	Gen	Car	Beta2	Last	First	AIC	Pratt	Genizi	Car	Beta2	Last	First	AIC	avg
lAge	29%	12%	16%	27%	12%	12%	12%	3%	4%	3%	3%	2%	3%	2%	25.3%	8.9%	13.1%	24.3%	9.4%	8.9%	9.8%	14.3%
lRentAbM	1%	5%	4%	19%	21%	0%	21%	-3%	1%	0%	3%	3%	3%	3%	4.0%	3.5%	4.4%	16.6%	17.8%	-2.6%	17.8%	8.8%
RF10y	9%	8%	8%	6%	11%	6%	11%	-1%	1%	0%	0%	0%	1%	0%	9.9%	7.6%	8.3%	5.8%	10.4%	4.9%	10.9%	8.3%
lVol2	8%	7%	7%	4%	4%	7%	4%	1%	1%	1%	0%	0%	2%	0%	7.4%	5.9%	6.4%	3.6%	3.5%	5.1%	3.8%	5.1%
lLandLev	9%	7%	8%	4%	6%	8%	6%	2%	3%	3%	7%	5%	1%	5%	7.0%	4.1%	5.1%	-2.5%	0.8%	7.6%	0.8%	3.3%
lVol	4%	5%	4%	2%	1%	5%	1%	0%	0%	0%	0%	0%	0%	0%	4.4%	4.3%	3.8%	1.4%	1.2%	5.0%	1.4%	3.1%
lAvgAppSize	6%	5%	5%	2%	2%	6%	2%	3%	3%	3%	3%	2%	3%	2%	2.4%	2.1%	3.0%	-0.8%	0.5%	3.2%	0.7%	1.6%
VAC	2%	2%	2%	1%	1%	2%	1%	-1%	1%	0%	0%	1%	1%	0%	2.6%	0.8%	2.0%	0.3%	0.8%	0.9%	1.0%	1.2%
GDP	2%	1%	1%	1%	2%	1%	2%	1%	1%	1%	1%	2%	1%	2%	0.3%	0.0%	-0.1%	-0.5%	-0.2%	0.2%	-0.2%	-0.1%
PctCom	-1%	1%	0%	0%	1%	1%	0%	0%	1%	1%	0%	0%	1%	0%	-1.5%	-0.2%	-0.9%	0.3%	0.4%	0.0%	0.5%	-0.2%
DNew	-2%	8%	6%	0%	0%	11%	0%	4%	5%	5%	3%	4%	5%	4%	-6.0%	3.2%	1.2%	-2.8%	-3.9%	5.9%	-4.0%	-0.9%
MIC	8%	7%	7%	4%	7%	7%	7%	10%	10%	10%	6%	6%	12%	6%	-1.4%	-2.5%	-2.8%	-1.8%	0.9%	-5.2%	0.9%	-1.7%
CQ	6%	8%	7%	1%	1%	12%	1%	8%	9%	9%	4%	5%	12%	5%	-2.3%	-1.6%	-1.6%	-3.1%	-3.7%	-0.6%	-3.9%	-2.4%
SP500PE	7%	7%	7%	3%	6%	6%	6%	10%	9%	9%	7%	10%	10%	10%	-2.8%	-2.5%	-2.8%	-4.1%	-4.1%	-3.7%	-4.3%	-3.5%
RenoY	-2%	2%	1%	0%	1%	3%	0%	5%	4%	4%	5%	5%	3%	5%	-6.2%	-1.9%	-3.4%	-4.9%	-4.6%	-0.5%	-4.8%	-3.8%
Cond	12%	10%	11%	4%	4%	14%	4%	21%	20%	20%	16%	21%	20%	22%	-8.8%	-9.4%	-9.5%	-11.8%	-16.6%	-6.3%	-17.2%	-11.4%
MCH	1%	5%	5%	20%	20%	0%	20%	35%	27%	31%	40%	32%	23%	33%	-34.4%	-22.2%	-26.3%	-20.0%	-12.6%	-22.8%	-13.3%	-21.6%

more important for appraisers

more important for investors

Note: The relative importance metrics are based on Pratt (1987), Genizi (1993), Zuber & Strimmer (2011), Darlington (1968) and Akaike (1974).

Each variable was mapped to an economically meaningful category (see rows one and two in Table 2). Thus, a question that naturally arises is whether the identified differences in relative importance appear because investors and appraisers weight proxies differently *within* a category, or whether the differences exist even *across* categories. If the latter were true, this would imply that the pricing process significantly differs with respect to risk and growth perceptions (and not just with respect to the proxies that are used to identify the risk and growth perceptions within each category). About half of the metrics can be calculated for both individual variables and groups of variables. We therefore cluster our variables into eight categories according to the components of *Equation (4).* Table 8 provides an overview of the mapping. Five of the groups represent different types of micro-level risks, i.e. refurbishment risk, illiquidity risk, tenant risk, land leverage and the percentage of commercial rents, with the latter capturing both tenant risk and variation in α. The remaining three groups are location, which captures micro-level variations in both g and r_p, MicMacG, which proxies for variations in g at both the micro and macro levels, and finally, Econ for the economic variables that do not vary across properties but over time due to changes in r_f, r_{p_macro} and g_{macro}. The results are reported in Table 9.

The most important group for both appraisers and investors is refurbishment risk. Renovations are often not necessary for quite a while, but as soon as they need to be done, cash flows turn into strongly negative territory, thereby constituting an important source of risk. The relative importance of refurbishment risk is more important for appraisers than investors for all three metrics. Another interesting observation is that the famous real estate ‘location, location, location’ dictum is still valid as location is the second most important group for both appraisers and investors, but again, its relative importance is much more pronounced for appraisers. As in the previous analysis, which was based on ungrouped variables, the importance of the percentage of commercial rents and that of tenant risk are by and large the same for investors and appraisers. Illiquidity risk, economic risk, and variations in the expected *NOI* growth rates (MicMacG), on the other hand, are all more important for investors across all metrics.

Table 8 Mapping of Groups and Variables

Group	Theoretical Interpretation/Component of Equation (4)	Included Variable(s)
RefRisk	r_{p_micro}	lAge, DNew, RenoY, CQ, Cond
IlliqRisk	r_{p_micro}	lVol, lVol2
TenantRisk	r_{p_micro}	lAvgAppSize
LandLeverage	r_{p_micro}	lLandLev
PctCom	α, r_{p_micro}	PctCom
Location	g_{micro}, r_{p_micro}	MIC, MCH
MicMacG	g_{micro} , g_{macro}	lRentAbM, VAC
Econ	r_f, r_{p_micro}, g_{macro}; variation over time/appraisal smoothing	RF10y, SP500PE, GDP

Table 9 Relative Importance of Groups

Group	Investors			Appraisers			Importance Investors - Appraisers			
Name	*First*	*Last*	*AIC*	*First*	*Last*	*AIC*	*First*	*Last*	*AIC*	*avg*
IlliqRisk	8%	8%	9%	1%	0%	0%	7.0%	8.0%	8.9%	8.0%
MicMacG	3%	14%	14%	1%	3%	3%	2.3%	10.2%	10.9%	7.8%
Econ	17%	16%	17%	15%	10%	11%	1.5%	5.9%	6.2%	4.5%
LandLeverage	10%	4%	4%	1%	4%	4%	9.1%	-0.4%	-0.4%	2.8%
TenantRisk	10%	2%	2%	5%	2%	1%	5.3%	0.0%	0.1%	1.8%
PctCom	1%	0%	0%	1%	0%	0%	0.5%	0.2%	0.4%	0.4%
RefRisk	36%	39%	37%	44%	44%	44%	-8.4%	-5.1%	-6.9%	-6.8%
Location	15%	17%	18%	32%	36%	37%	-17.4%	-18.7%	-19.2%	-18.4%

Note: The relative importance metrics are based on Darlington (1968) and Akaike (1974).

Both groups that capture variation over time, i.e. Econ and MicMacG, have overall a relative importance of about 14% for appraisers and 27% for investors. Given this finding, it is not surprising that appraisal-based real estate indices have been found to be smoothed (Matysiak & Wang, 1995; Diaz & Wolverton, 1998; Fisher & Geltner, 2000; Clayton et al., 2001; Edelstein & Quan, 2006; Cannon & Cole, 2011). As appraisers underweight variables that change over time at the cost of variables that hardly change over time, it seems plausible that appraisal-based values are smoother than transaction prices. This constitutes new evidence that might add to the appraisal-smoothing discussion. While most studies use a univariate approach to unsmooth valuation-based indices and to uncover the true volatility, a recent study by Wang (2006) argues in favor of a multivariate approach where the degree to which the index is smoothed is inferred from the examination of economic forces. Our findings deliver evidence that this approach is likely to be better suited as it tackles the issue at its source.

A related observation is that appraisers are more concerned than investors with location and refurbishment risk and less so with economic risk and expected *NOI* growth (MicMacG). Location and refurbishment risk mainly capture variations in cap rates at the property-specific level, and thus are easily diversifiable, while the economic risks and expected *NOI* growth capture variations mainly at the macro level, thereby making diversification difficult if not impossible. These findings imply that appraisers have a stronger focus on the individual property as they price properties mainly based on property-specific factors, while investors have a wider perspective and strongly think in terms of a portfolio as their pricing process is more strongly influenced by non-diversifiable risks.

5.3 Additional Robustness Checks

We previously observed that our models were stable across different specifications of how time is accounted for (specification with time dummies vs. without time consideration vs. with time consideration by using economic variables). Also, the selection of the time period did not affect the results for the transaction-based sample (1985–2010 vs. 1995–2010). In this section, we perform two additional tests to further investigate the stability of our results.

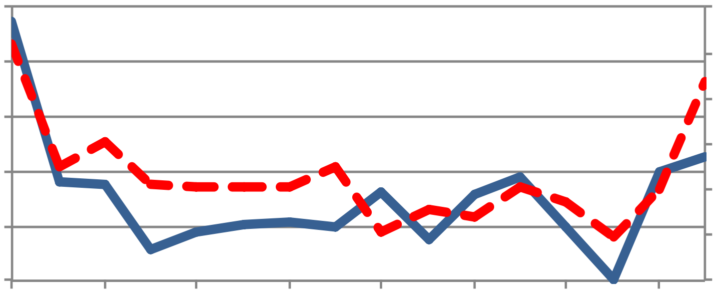
Our first analysis complements the initial findings with respect to the time period selection for the transaction-based sample; i.e., for the joint sample, we are interested in the stability of our findings when observations from a single year are excluded. Table 10 presents these results and shows the average difference in the relative importance of variables and groups of variables between appraisers and investors over all metrics when a given year is omitted. Overall, the results are found to be very stable. Variables that used to have the most pronounced differences continue to show important differences, and those that showed less pronounced differences continue to exhibit minor differences.

The risk-free rate warrants some further discussion. The relative importance of the risk-free rate, although still positive (i.e., more important for investors than for appraisers), is substantially less positive when data for year 1995 are excluded and somewhat less positive when year 2010 is excluded. In fact, this observation reinforces our findings rather than question their stability. During the 1995–2010 period, interest rates were never higher than their level in 1995 and never lower than their level in 2010. Thus, if investors are indeed more concerned with the opportunity cost of capital, the exclusion of data for any of these two years eliminates a large amount of the explained variance for the transaction-based sample. As a consequence, their elimination will lower the relative importance of this variable. In order for it to be a valid argument, we should observe this pattern for any given omitted year when the risk-free rate is either high or low as compared with its average level. Figure 3 shows that this is indeed the case, as the relative importance is always more pronounced for years when the risk-free rate is unusually high or low, and almost unaffected whenever a year is excluded that has a risk-free rate close to its average level. The correlation between the two series is 0.80.

Table 10 Robustness of Results with Omitted Years

Variable/group of variables	**Year that was excluded**																
Name	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*none*
lAge	13.0%	13.2%	13.3%	14.5%	14.1%	14.4%	14.0%	16.0%	14.7%	15.4%	15.0%	14.9%	13.9%	16.3%	16.3%	16.0%	14.3%
lRentAbM	9.4%	9.3%	8.9%	8.7%	9.0%	9.0%	8.9%	9.0%	8.1%	8.4%	8.3%	8.9%	8.7%	8.2%	9.1%	9.1%	8.8%
RF10y	1.8%	7.2%	6.2%	8.0%	8.2%	8.1%	8.1%	7.3%	10.1%	9.1%	9.5%	8.1%	8.8%	10.3%	8.3%	3.6%	8.3%
lVol2	5.1%	5.3%	5.2%	5.3%	4.8%	5.0%	3.9%	4.8%	5.1%	5.1%	4.5%	5.8%	5.3%	5.1%	5.0%	4.7%	5.1%
lLandLev	3.8%	3.7%	3.5%	3.3%	3.3%	3.5%	2.5%	3.6%	4.2%	3.3%	2.9%	2.9%	3.7%	2.0%	2.7%	3.7%	3.3%
lVol	3.2%	3.0%	3.5%	3.0%	3.0%	3.1%	3.9%	3.2%	2.3%	3.3%	2.7%	3.2%	3.3%	3.1%	2.9%	3.0%	3.1%
lAvgAppSize	1.7%	1.1%	1.5%	1.7%	1.3%	1.7%	0.9%	1.7%	0.2%	-0.1%	0.7%	1.6%	1.9%	1.6%	1.1%	1.3%	1.6%
VAC	1.3%	0.9%	1.1%	0.8%	1.3%	1.2%	0.9%	1.1%	1.5%	1.4%	0.8%	1.0%	1.0%	1.5%	1.2%	1.2%	1.2%
GDP	-1.2%	-0.1%	-0.1%	-0.2%	0.0%	-0.1%	-0.3%	0.9%	-0.1%	0.5%	-0.2%	-0.1%	0.9%	-0.7%	-0.6%	-1.8%	-0.1%
PctCom	-0.1%	-0.2%	0.0%	-0.1%	-0.2%	-0.2%	-0.3%	-0.4%	-0.6%	-0.6%	-0.3%	-0.2%	-0.1%	-0.1%	-0.2%	-0.1%	-0.2%
DNew	-1.7%	-1.0%	-0.8%	-1.1%	-0.8%	-0.8%	-0.8%	-0.6%	-0.4%	0.3%	0.6%	-0.1%	1.2%	-0.5%	0.0%	-0.3%	-0.9%
MIC	-0.6%	-1.2%	-2.0%	-2.7%	-1.7%	-1.6%	-1.8%	-1.5%	-2.1%	-1.2%	-0.4%	-0.9%	-3.2%	-2.8%	-3.7%	-2.1%	-1.7%
CQ	-0.9%	-1.4%	-0.9%	-1.4%	-1.8%	-2.0%	-1.5%	-1.3%	-2.2%	-2.3%	-3.3%	-3.1%	-2.7%	-2.7%	-1.0%	-1.3%	-2.4%
SP500PE	1.7%	-4.0%	-3.8%	-3.9%	-3.7%	-5.6%	-1.8%	-2.0%	-3.6%	-2.8%	-3.3%	-4.2%	-6.0%	-3.9%	-5.2%	-1.8%	-3.5%
RenoY	-4.8%	-3.5%	-3.3%	-3.4%	-3.7%	-3.8%	-4.3%	-4.7%	-4.4%	-4.9%	-4.4%	-4.0%	-3.4%	-4.5%	-3.8%	-3.8%	-3.8%
Cond	-10.3%	-10.9%	-11.1%	-11.9%	-11.5%	-11.1%	-10.8%	-15.3%	-12.3%	-14.4%	-12.6%	-11.9%	-10.4%	-10.4%	-9.4%	-9.8%	-11.4%
MCH	-21.4%	-21.4%	-21.2%	-20.6%	-21.5%	-20.7%	-21.6%	-21.8%	-20.4%	-20.5%	-20.3%	-21.7%	-22.8%	-22.4%	-22.7%	-21.7%	-21.6%
IlliqRisk	8.1%	8.1%	8.5%	8.4%	7.9%	8.1%	8.0%	7.9%	7.5%	8.4%	7.4%	8.6%	8.3%	8.0%	7.9%	7.8%	8.0%
MicMacG	8.5%	8.4%	8.4%	8.1%	8.6%	8.6%	8.2%	8.8%	8.3%	8.4%	7.7%	8.3%	8.1%	8.1%	8.5%	8.5%	7.8%
Econ	3.4%	3.2%	2.5%	3.4%	4.0%	2.3%	4.7%	4.2%	5.3%	5.5%	4.5%	2.9%	2.6%	4.6%	1.7%	0.9%	4.5%
LandLeverage	2.6%	3.2%	2.9%	2.9%	2.9%	3.1%	2.8%	3.2%	3.1%	2.9%	2.8%	2.8%	3.2%	2.5%	2.5%	3.2%	2.8%
TenantRisk	1.4%	1.6%	2.0%	2.2%	1.8%	2.2%	1.8%	2.3%	0.9%	0.7%	1.2%	1.9%	2.0%	1.9%	1.7%	2.5%	1.8%
PctCom	0.3%	0.5%	0.6%	0.6%	0.4%	0.4%	0.3%	0.5%	0.1%	0.1%	0.3%	0.4%	0.4%	0.4%	0.3%	0.6%	0.4%
RefRisk	-7.2%	-7.1%	-6.3%	-6.8%	-7.2%	-7.0%	-7.5%	-8.3%	-7.4%	-8.5%	-7.1%	-7.0%	-4.4%	-5.7%	-2.4%	-4.8%	-6.8%
Location	-17.2%	-17.8%	-18.5%	-18.8%	-18.5%	-17.8%	-18.3%	-18.7%	-17.9%	-17.5%	-16.7%	-17.9%	-20.3%	-19.9%	-20.2%	-18.7%	-18.4%

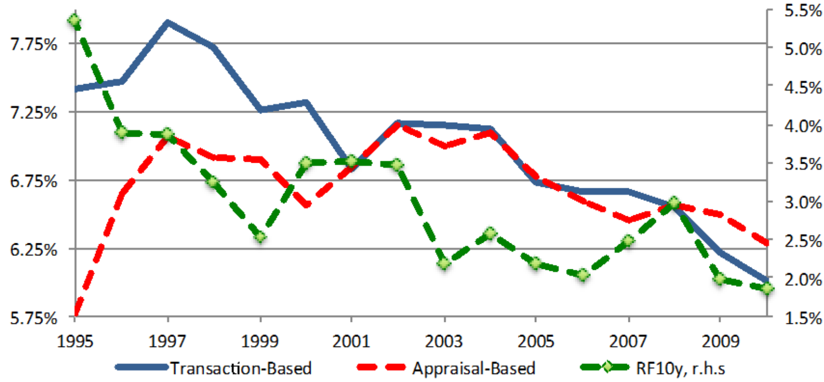
Figure 3 Deviation of the Risk-Free Rate from its Average Level and Change in Relative Importance of the Risk-Free Rate by Year Excluded



We also want to discuss the potential for spurious regression in relation to the results for the risk-free rate. Based on our models, we are able to determine the evolution of constant-quality cap rates. Their evolution, as derived from the time dummy models, is plotted in Figure 4 together with the evolution of the risk-free rate.

While the appraisal-based cap rates appear to be stationary, the transaction-based cap rates and the risk-free rateboth show a clear downward trend. Of course, over a longer period, all three series would most likely be stationary. Nevertheless, the fact that we might have *I(1)* integrated variables during the analyzed period raises the question of spurious regression. That is, we cannot rule out the possibility that we find a significant link between the risk-free rate and transaction-based cap rates, when in fact, they are independent from one another and just share the same trend. However, theory clearly predicts a link between these two series, and therefore it is somewhat doubtful that the link should be spurious. In addition, if the link was spurious, why would transaction-based cap rates follow the same trend, but not appraisal-based cap rates? In any case, we use cointegration and error-correction models (ECMs) to dig deeper into this issue. We apply the approach developed by Pesaran&Pesaran(1997) and Pesaran et al. (2001), which is valid independently of the order of integration of the variables and calculate an ECM specification that would be comparable with the specifications from our models derived from *Equation (4)*, i.e. where the log of the cap rate is cointegrated with the risk-free rate, P/E, and GDP. Both tests for the existence of a long-run relationship (i.e., the t-test for the significance of the error-correction term and the Wald F-test for the joint significance of the lagged levels of the variables) indicate that the error correction specification is significant at the 1% level. The estimate of the error-correction term is not statistically different from unity, which implies that it is possible that 100% of the deviations from equilibrium are corrected within one year. In addition, the estimates of the long-term coefficients are comparable to those presented in Table 6, i.e. the sensitivity of the cap rate to the risk-free rate would fall slightly from 0.047 to 0.039, while the sensitivity to the P/E would be 0.004 instead of 0.005. The coefficient for GDP would change from -0.006 to -0.013. The findings from the ECM specification provide evidence that a relationship between transaction-based cap rates and the risk-free rate does indeed exist and that deviations from the long-term equilibrium are immediately corrected. The finding with relation to the risk-free rateis therefore not spurious.

Figure 4 Constant-Quality Cap Rates and Risk-Free Interest Rate



6. Conclusions

Extant research that analyzes the variation in cap rates at the micro level has documented that property-specific risks, such as land leverage, ownership leverage, refurbishment risk, and illiquidity risk, are useful in explaining cap rate variations. With respect to these four categories, we are able to identify some additional variables that are important in explaining the cap rate variability, especially construction quality and building condition. We also find that in addition to these four categories, another four micro-level risk categories are priced by investors, i.e. tenant diversification, tenant risk, regulatory risk, and the degree to which the transaction is conducted on a transparent and free market (arm's length vs. auction vs. off-market transactions).

The cap rate is an important metric for both real estate valuation and overall market assessments. Given that appraisal-based data are usually more readily available in many markets, but that such data have been criticized for their potential limitations, the focus of this paper has been on the assessment of the similarities and differences between the determinants of appraisal-based and transaction-based cap rates. We find important differences in how investors (transaction-based data) and appraisers (valuation-based data) weight different information when determining the price of a property (and thus the cap rate). Our results show that appraisers overweight the factors that they can easily observe when they appraise a property, i.e. location, the building condition, and construction quality, at the cost of illiquidity risk, land leverage, age of the property, and the opportunity cost of capital. Overall, we find that variables that change over time are more important for investors than appraisers. This is an important finding for the appraisal-smoothing debate, as it adds to the explanation of why appraisal-based indices could be smoothed. Another implication of our results is that appraisers are more concerned with location and refurbishment risks and less so with economic risks and potential variations in expected *NOI* growth at the macro level. As location and refurbishment risks mainly capture variations at the micro level in both the risk premium and the expected *NOI* growth, they are easily diversifiable. Economic variables and potential variations in *NOI* growth at the macro level, on the other hand, are difficult if not impossible to diversify. This implies that appraisers have a stronger focus on the individual property as they price properties mainly based on property-specific factors, while investors use a wider perspective and strongly think in terms of portfolios given that their pricing process is more strongly influenced by non-diversifiable risks.

This study is based on two different samples from the same market, where about 10% of all properties appear in both samples. The degree of comparability between the determinants of appraisal-based and transaction-based cap rates could be even greater in future research if for each property, a single sample that contains both an appraisal-based cap rate and an implicit cap rate from a subsequent sale were made available. This would also enable the analysis of the driving forces for the *differences* between the two cap rates. In addition, the findings of this paper are based on Swiss data. Another fruitful avenue for future research would be to determine whether there are differences across countries in the pricing of properties by appraisers and investors. The education of appraisers varies from country to country and this may lead to differences. On the other hand, it is only human to overweight factors that one can easily observe at the cost of factors that are less easily observable, thus suggesting that similar results could be found across countries.

We maintain that the results are also of relevance to both investors and appraisers as they may increase the awareness of appraisers for factors that they do not easily observe, but that are priced by investors. However, we believe that it would not necessarily be a wise strategy for appraisers to blindly imitate the pricing process of investors as transaction prices are likely not perfectly efficient either because there exist incentives for a herding behavior by investors (Lux, 1995; DeCoster & Strange, 2012; Hott, 2012; Zhou & Anderson, 2013). In addition, transaction prices can also be smoothed and lagged to some degree because transaction prices usually represent the agreed prices that are based on negotiations which occurred a few weeks prior to recording. This delay is often referred to as the 'escrow period' and varies from deal to deal, hence the potential lagging and smoothing. To reduce inconsistences between appraisers and investors in the future, it seems useful for investors and appraisers (and also for researchers) to better understand the pricing process of other market participants and be aware of similarities and differences in the first place. This should increase transparency and hopefully lead to more rational prices and valuations in the future.

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References

Akaike, H. (1974). A New Look at the Statistical Model Identification, IEEE Transactions on Automatic Control, 19, 6, 716–723.

Ambrose, B. and Nourse, H. (1993). Factors Influencing Capitalization Rates, Journal of Real Estate Research, 8, 2, 221–237.

Assenmacher-Wesche, K. and Pesaran, H. (2009). A VECX* Model of the Swiss Economy, Swiss National Bank Economic Studies, No. 6.

Blundell, G. and Ward, C. (1987). Property Portfolio Allocation: A Multi-factor Model, Land Development Studies, 4, 2, 145–156.

Bond, S., Hwang, S. and Marcato, G. (2013). Commercial Real Estate Returns: An Anatomy of Smoothing in Asset and Index Returns, Real Estate Economics, 40, 4, 637–661.

Bostic, R., Longhofer, S. and Redfearn, C. (2007). Land Leverage: Decomposing Home Price Dynamics, Real Estate Economics, 35, 2, 183–208.

Bourassa, S., Haurin, D., Haurin, J., Hoesli, M. and Sun, J. (2009). House Price Changes and Idiosyncratic Risk: The Impact of Property Characteristics, Real Estate Economics, 37, 2, 259–278.

Bourassa, S., Hoesli, M. and Scognamiglio, D. (2010). International Articles: Housing Finance, Prices, and Tenure in Switzerland, Journal of Real Estate Literature, 18, 2, 261–282.

Bourassa, S., Hoesli, M., Scognamiglio, D. and Sormani, P. (2008). Constant-Quality House Price Indexes for Switzerland, Swiss Journal of Economics and Statistics, 144, 4, 561–575.

Bourassa, S., Hoesli, M., Scognamiglio, D. and Zhang, S. (2011). Land Leverage and House Prices, Regional Science & Urban Economics, 41, 2, 134–144.

Cannon, S. and Cole, R. (2011). How Accurate Are Commercial Real Estate Appraisals? Evidence from 25 Years of NCREIF Sales Data, Journal of Portfolio Management, 37, 5, 68–88.

Chaney, A. and Hoesli, M. (2010). The Interest Rate Sensitivity of Real Estate, Journal of Property Research, 27, 1, 61–85.

Chen, J., Hudson-Wilson, S. and Nordby, H. (2004). Real Estate Pricing: Spreads and Sensibilities: Why Real Estate Pricing Is Rational, Journal of Real Estate Portfolio Management, 10, 1, 1–21.

Cheng, P., Lin, Z. and Liu, Y. (2011). Heterogeneous Information and Appraisal Smoothing, Journal of Real Estate Research, 33, 4, 443–469.

Chervachidze, S., Costello, J. and Wheaton, W. (2010). The Secular and Cyclical Determinants of Capitalization Rates: The Role of Property Fundamentals, Macroeconomic Factors, and “Structural Changes,” Journal of Portfolio Management, 35, 5, 50–69.

Chervachidze, S. and Wheaton, W. (2013). What Determined the Great Cap Rate Compression of 2000–2007, and the Dramatic Reversal During the 2008–2009 Financial Crisis?, Journal of Real Estate Finance and Economics, 46, 2, 208–231.

Clayton, J., Geltner, D. and Hamilton, S. (2001). Smoothing in Commercial Property Valuations: Evidence from Individual Appraisals, Real Estate Economics, 29, 3, 337–360.

Clayton, J., Ling, D. and Naranjo, A. (2009). Commercial Real Estate Valuation: Fundamentals Versus Investor Sentiment, Journal of Real Estate Finance and Economics, 38, 1, 5–37.

Cole, R., Guilkey, D. and Miles, M. (1986). Toward an Assessment of the Reliability of Commercial Appraisals, Appraisal Journal, 54, 3, 422–432.

Constantinescu, M. (2010). What Is the "Duration" of Swiss Direct Real Estate, Journal of Property Investment and Finance, 28, 3, 181–197.

Darlington, R. (1968). Multiple Regression in Psychological Research and Practice, Psychological Bulletin, 69, 3, 161–182.

Davis, M. and Heathcote, J. (2007). The Price and Quantity of Residential Land in the United States, Journal of Monetary Economics, 54, 8, 2595–2620.

DeCoster, G. and Strange, W. (2012). Developers, Herding, and Overbuilding, Journal of Real Estate Finance and Economics, 44, 1-2, 7–35.

Diaz, J. and Wolverton, M. (1998). A Longitudinal Examination of the Appraisal Smoothing Hypothesis, Real Estate Economics, 26, 2, 349–358.

Edelstein, R. and Quan, D. (2006). How Does Appraisal Smoothing Bias Real Estate Returns Measurement?, Journal of Real Estate Finance & Economics, 32, 1, 41–60.

Evans, R. (1990). A Transfer Function Analysis of Real Estate Capitalization Rates, Journal of Real Estate Research, 5, 3, 371–380.

Fisher, J. and Geltner, D. (2000). De-Lagging the NCREIF Index: Transaction Prices and Reverse Engineering, Real Estate Finance, 17, 1, 7–22.

Fisher, J., Miles, M. and Webb, B. (1999). How Reliable Are Commercial Appraisals? Another Look, Real Estate Finance, 16, 3, 9–15.

Froland, C. (1987). What Determines Cap Rates in Real Estate, Journal of Portfolio Management, 13, 77–83.

Geltner, D. (1989). Bias in Appraisal-Based Returns, Real Estate Economics, 17, 3, 338–352.

Geltner, D. (1991). Smoothing in Appraisal-Based Returns, Journal of Real Estate Finance and Economics, 4, 3, 327–345.

Genizi, A. (1993). Decomposition of R2 in Multiple Regression with Correlated Regressors, Statistica Sinica, 3, 407–420.

Gordon, M. (1962). The Investment, Financing and Valuation of the Corporation. R. D. Irwin: Homewood, IL.

Gunnelin, A., Hendershott, P., Hoesli, M. and Söderberg, B. (2004). Determinants of Cross-Sectional Variation in Discount Rates, Growth Rates and Exit Cap Rates, Real Estate Economics, 32, 2, 217–237.

Hendershott, P. and MacGregor, B. (2005a). Investor Rationality: An Analysis of NCREIF Commercial Property Data, Journal of Real Estate Research, 27, 4, 445–475.

Hendershott, P. and MacGregor, B. (2005b). Investor Rationality: Evidence from U.K. Property Capitalization Rates, Real Estate Economics, 33, 2, 299–322.

Hendershott, P. and Turner, B. (1999). Estimating Constant-Quality Capitalization Rates and Capitalization Effects of Below Market Financing, Journal of Property Research, 16, 2, 109–122.

Hersberger, D. (2008). Wertermittlung mit dem DCF-Verfahren [Valuation with the DCF method]. Immobilien Zeitung Verlagsgesellschaft: Thesis, Wiesbaden.

Hoaglin, D., Mosteller, F. and Tukey, J. (2000). Understanding Robust and Exploratory Data Analysis. John Wiley & Sons: New York.

Hoffman, P. (1960). The Paramorphic Representation of Clinical Judgment, Psychological Bulletin, 57, 116–131.

Hott, C. (2012). The Influence of Herding Behaviour on House Prices, Journal of European Real Estate Research, 5, 3, 177–198.

Huber, P. (1981). Robust Statistics. John Wiley & Sons: New York.

IAZI (2011). IAZI Swiss Property Benchmark 2011. Zurich, Switzerland.

Janssen, C., Söderberg, B. and Zhou, J. (2001). Robust Estimation of Hedonic Models of Price and Income for Investment Property, Journal of Property Investment & Finance, 19, 4, 342–360.

Jud, G. and Winkler, D. (1995). The Capitalization Rate of Commercial Properties and Market Returns, Journal of Real Estate Research, 10, 5, 509–518.

Lai, T.-Y. and Wang, K. (1998). Appraisal Smoothing: The Other Side of the Story, Real Estate Economics, 26, 3, 511–535.

Lux, T. (1995). Herd Behaviour, Bubbles and Crashes, The Economic Journal, 105, 431, 881–896.

Maronna, R., Martin, R. and Yohai, V. (2006). Robust Statistics: Theory and Methods. John Wiley & Sons: Chichester, UK.

Matysiak, G. and Wang, P. (1995). Commercial Property Market Prices and Valuations: Analysing the Correspondence, Journal of Property Research, 12, 3, 181–202.

McDonald, J. and Dermisi, S. (2008). Capitalization Rates, Discount Rates, and Net Operating Income: The Case of Downtown Chicago Office Buildings, Journal of Real Estate Portfolio Management, 14, 4, 363–374.

McDonald, J. and Dermisi, S. (2009). Office Building Capitalization Rates: The Case of Downtown Chicago, Journal of Real Estate Finance and Economics, 39, 4, 472–485.

Netzell, O. (2009). A Study of Micro-Level Variation in Appraisal-Based Capitalisation Rates, Journal of Property Research, 26, 3, 235–263.

Newey, W. and West, K. (1987). A Simple, Positive Semi-Definite, Heteroskedasticity and Autocorrelation Consistent Covariance Matrix, Econometrica, 55, 3, 703–708.

Nichols, J., Oliner, S. and Mulhall, M. (2013). Swings in Commercial and Residential Land Prices in the United States, Journal of Urban Economics, 73, 1, 57–76.

Nourse, H. (1987). The “Cap Rate,” 1966-1984: A Test of the Impact of Income Tax Changes on Income Property, Land Economics, 63, 2, 147–152.

Pesaran, H. and Pesaran, B. (1997). Working with Microfit 4.0 : Interactive Econometric Analysis. Oxford University Press: Oxford.

Pesaran, H., Shin, Y. and Smith, R. (2001). Bounds Testing Approaches to the Analysis of Level Relationships, Journal of Applied Econometrics, 16, 3, 289–326.

Pratt, W. (1987). Dividing the Indivisible: Using Simple Symmetry to Partition Variance Explained in: Proceedings of Second Tampere Conference in Statistics, (pp. 245–260). University of Tampere: Tampere, Finland, 1987.

Quan, D. and Quigley, J. (1989). Inferring an Investment Return Series for Real Estate from Observations on Sales, Journal of the American Real Estate & Urban Economics Association, 17, 2, 218–230.

Quan, D. and Quigley, J. (1991). Price Formation and the Appraisal Function in Real Estate Markets, Journal of Real Estate Finance and Economics, 4, 2, 127–146.

RICS Switzerland (2007). Swiss Valuation Standards (SVS) – Best Practice of Real Estate Valuation in Switzerland. Vdf Hochschulverlag: Zurich.

Rousseeuw, P. and Leroy, A. (2005). Robust Regression and Outlier Detection. John Wiley & Sons: Hoboken, NJ.

Saderion, Z., Smith, B. and Smith, C. (1994). An Integrated Approach to the Evaluation of Commercial Real Estate, Journal of Real Estate Research, 9, 2, 151–167.

Scognamiglio, D. (2000). Methoden Zur Immobilienbewertung Im Vergleich - Eine Empirische Untersuchung für Schweizer Wohnimmobilien [Methods of Real Estate Valuations - an Empirical Investigation for Swiss Residential Properties]. University of Berne: Thesis, Berne.

Shiller, R. (2005). Irrational Exuberance. Princeton University Press: Princeton.

Sivitanides, P., Southard, J., Torto, R. and Wheaton, W. (2001). The Determinants of Appraisal-Based Capitalization Rates, Real Estate Finance, 18, 2, 27–38.

Sivitanidou, R. and Sivitanides, P. (1996). Office Capitalization Rates: Why Do They Vary Across Metropolitan Markets, Real Estate Issues, 21, 34–39.

Sivitanidou, R. and Sivitanides, P. (1999). Office Capitalization Rates: Real Estate and Capital Market Influences, Journal of Real Estate Finance and Economics, 18, 3, 297–322.

Wang, P. (2006). Errors in Variables, Links Between Variables and Recovery of Volatility Information in Appraisal-Based Real Estate Return Indexes, Real Estate Economics, 34, 4, 497–518.

Zhou, J. and Anderson, R. (2013). An Empirical Investigation of Herding Behavior in the U.S. REIT Market, Journal of Real Estate Finance and Economics, 47, 1, 83-108.

Zuber, V. and Strimmer, K. (2011). High-Dimensional Regression and Variable Selection Using CAR Scores, Statistical Applications in Genetics and Molecular Biology, 10, 1, 1–27.