An Empirical Evaluation of Normative Commercial Real Estate Swap Pricing

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- General methodological discussion

- Methodology and contributions to literature

- Forecasts and fair swap prices

- Discussion

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# General methodological discussion

- The real estate derivative market is in its infancy.

- A reason for this may be the pricing.

- Derivatives are primarily based on appraisal-based indices.

- Real estate swaps are the main type traded so far.

- **How important are adjustment terms to obtain fair swap prices?**

Benefits of real estate derivatives
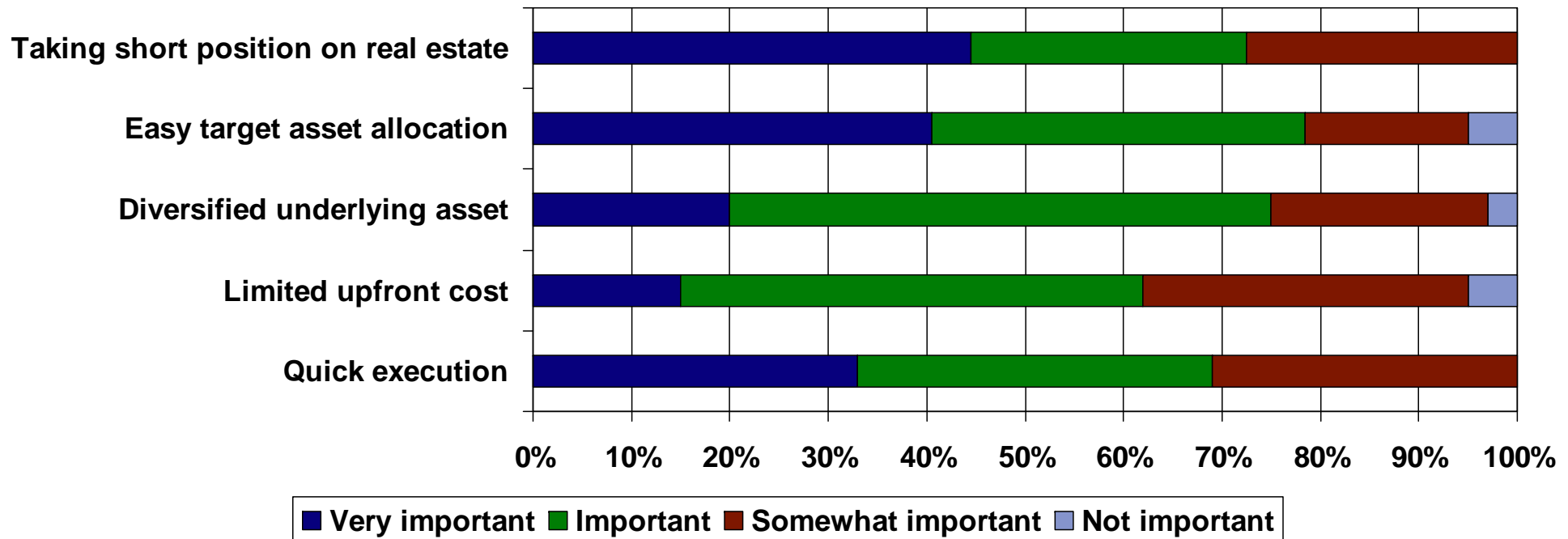
Source: Lim & Zhang (2006). A 2006 survey, conducted at the MIT Center for Real Estate, of 37 U.S. real estate investment managers and other likely participants

Mayor concerns in real estate derivatives (Top 6)
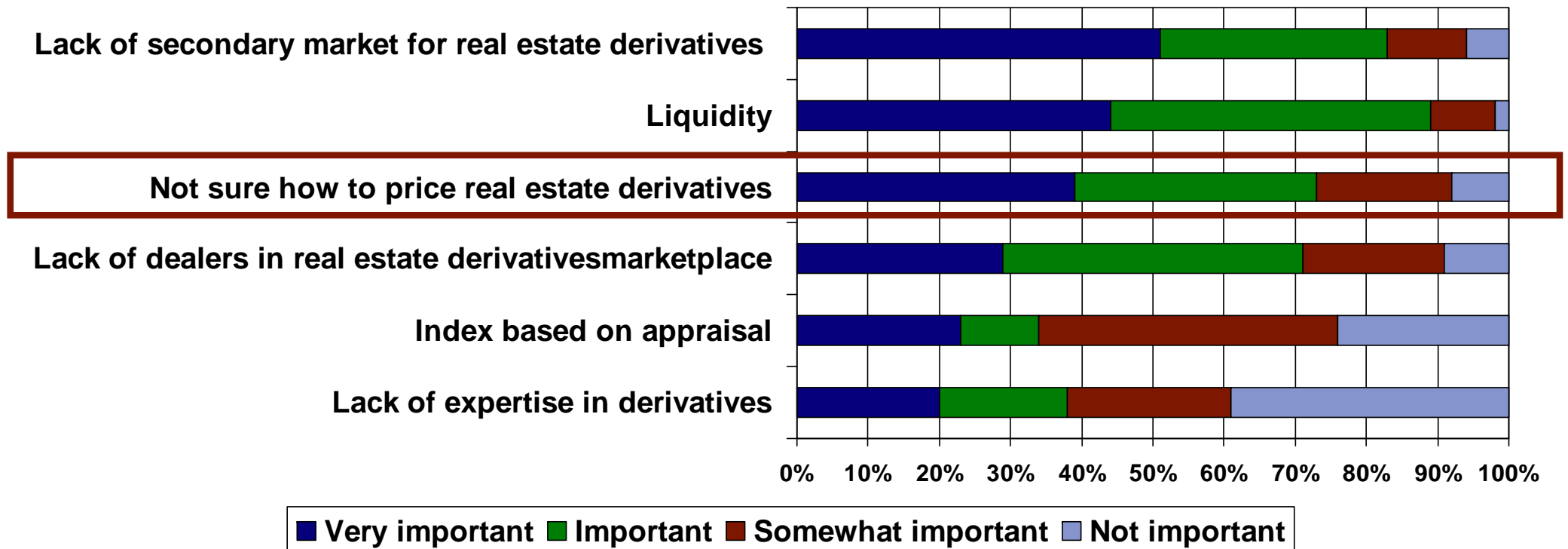
Source: Lim & Zhang (2006). A 2006 survey, conducted at the MIT Center for Real Estate, of 37 U.S. real estate investment managers and other likely participants

General methodological discussion

- Use VAR approach

- Use annual datasets for UK and US

- Direct real estate returns by use of index returns, since swaps are based on (appraisal-based) indexes

- Include return on securitized real estate as predictor of direct real estate returns (Giliberto 1990, Gyourko and Keim 1992, Barkham and Geltner 1995).

- Include cap rate as state variable: Captures cyclicality / mean reversion in direct real estate returns

- Yield spread; ten years T-bonds - three months treasury bills

Sample statistics

	UK			US		
	Mean	St.Dv.	Auto-correlation	Mean	St.Dv.	Auto-correlation
Appraisal-based index return	11.67%	11.69%	34.03%	9.83%	6.79%	64.49%
Return on securitized real estate	14.97%	34.08%	-17.45%	13.54%	18.12%	12.24%
Cap rate	6.03%	1.37%	77.65%	7.62%	1.05%	89.96%
Yield spread	0.72%	2.05%	45.69%	1.53%	1.51%	43.91%

This table shows statistics for the variables included in the VAR models, which are based on annual data. The sample period is 1971 to 2008 for the UK VAR. The US NPI sample period is 1978 to 2008. St.Dv.: Standard deviation. Autocorrelation refers to the first-order autocorrelation.

- Empirical evaluation of normative swap pricing suggested by Geltner and Fisher (2007). Approach is based on equilibrium considerations, not on arbitrage approach as in Buttimer et al. (1997), Björk and Clapham (2002) and Patel and Pereira (2008)

- Fair forward price: $F_{t,k} = E_t(R_{I,k}) - RP_I^E$

  where: F :   Fixed payment,

  $E_t(R_{I,k})$:   Expected index return for forecast period k

  RP_I^E :   Equilibrium risk premium of index returns

- Equilibrium risk premium following Geltner (1991): $RP_I^E = \omega RP_M^E$

- Geltner (1993) suggests a value of $\omega = 0.4$ for annual US NPI returns. Barkham and Geltner (1994), building on the work of Geltner (1993), suggest a value of $\omega = 0.625$ for annual UK returns.

- Fair swap prices are weighted averages of forward prices

- We can obtain the fair price of a swap with maturity of *K* years, $S_t(K)$, by solving:

$$\sum_{k=1}^{K} F_{t,k} \cdot DF_t^{(k)} = \sum_{k=1}^{K} S_t(K) \cdot DF_t^{(k)},$$

where $DF_t^{(k)} = 1/(1 + R_{f,t}^{(k)})$ is the factor for discounting a risk-free cash flow for *k* periods. $R_{f,t}^{(k)}$ refers to the term structure of spot rates at time *t*.
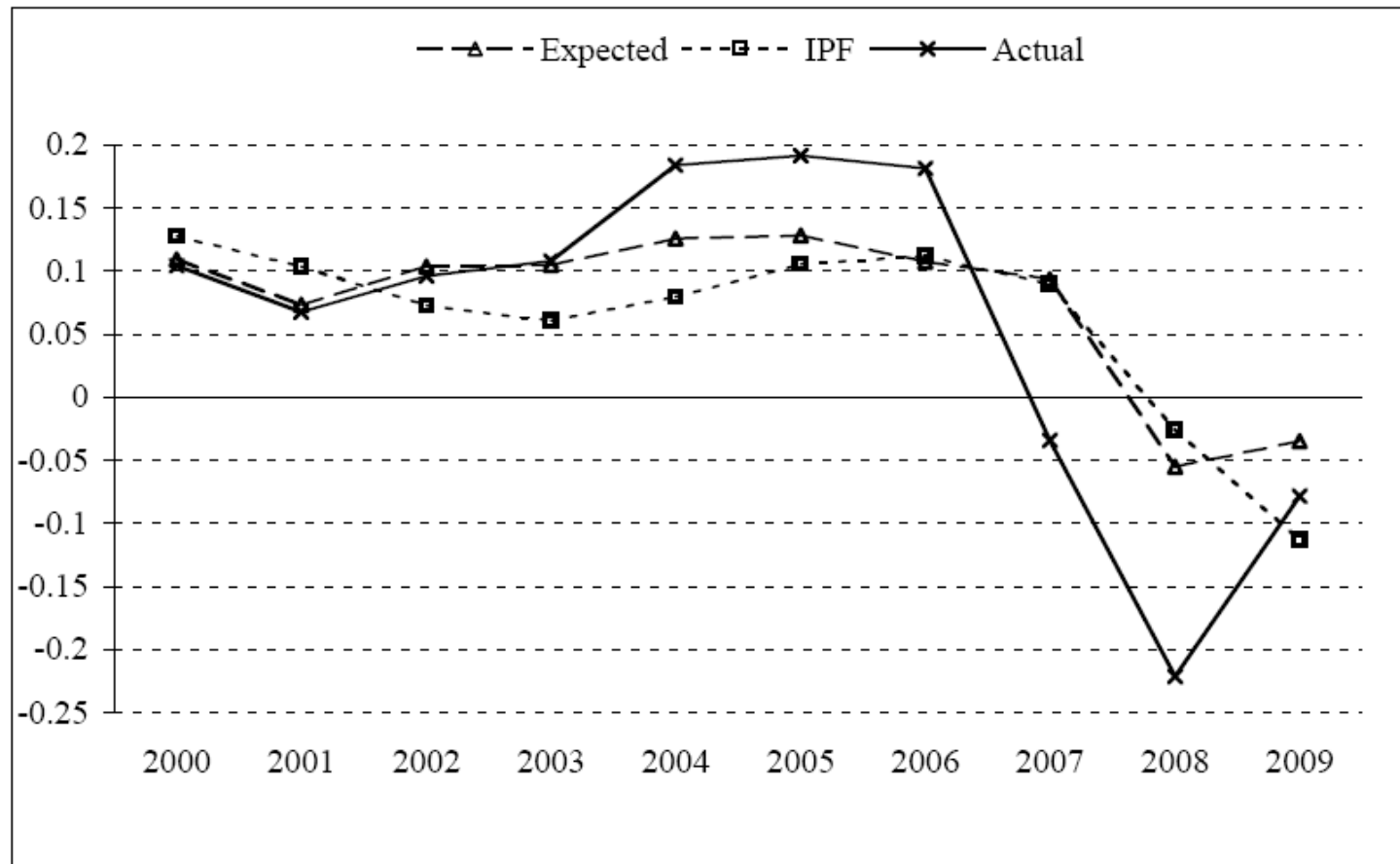
- Assume that a VAR(1) model captures the dynamic relationships between these variables.

$$z_{t+1} = \mathbf{\Phi_0} + \mathbf{\Phi_1 z_1} + \mathbf{v_{t+1}}$$

where Φ_0 is a (4x1) vector of constants and Φ_1 is a (4x4) coefficient matrix. The shocks are stacked in the (4x1) vector v_{t+1}.
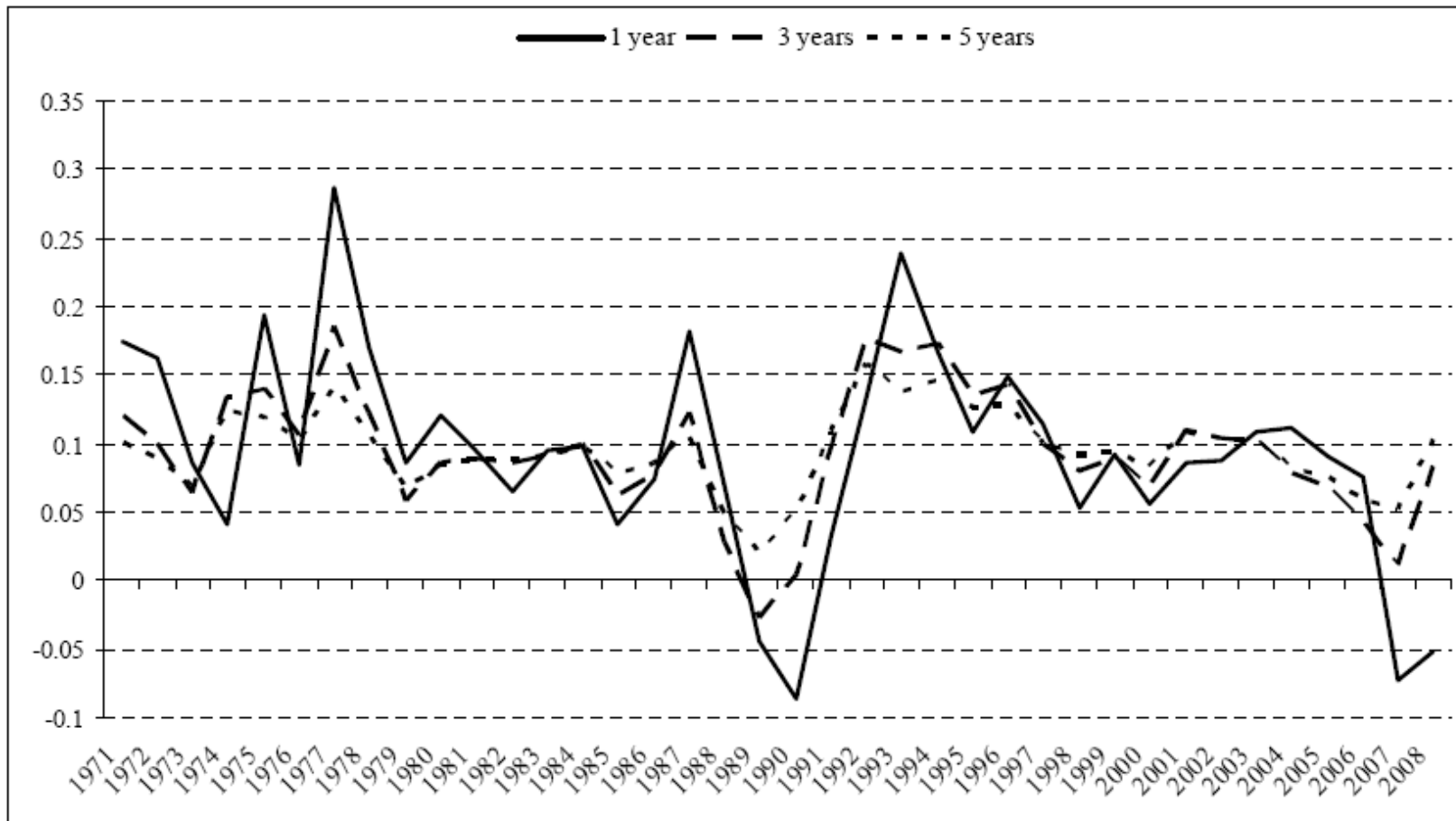
- The k-step (k= 1, …, 5) conditional forecast of the vector can be obtained recursively by:

$$E(z_{t+k}) = \mathbf{\Phi_0} + \mathbf{\Phi_1} E(\mathbf{z_{t+k-1}})$$

This figure shows expected returns obtained from the VAR model, the IPF consensus forecasts and the actual outcome of the IPD annual index return. The 2009 actual outcome is the annual IPD estimate as of end of September 2009.

This figure shows fair swap prices with maturity of one, three and five years, based on the VAR results.

Swap prices obtained from VAR approach: US
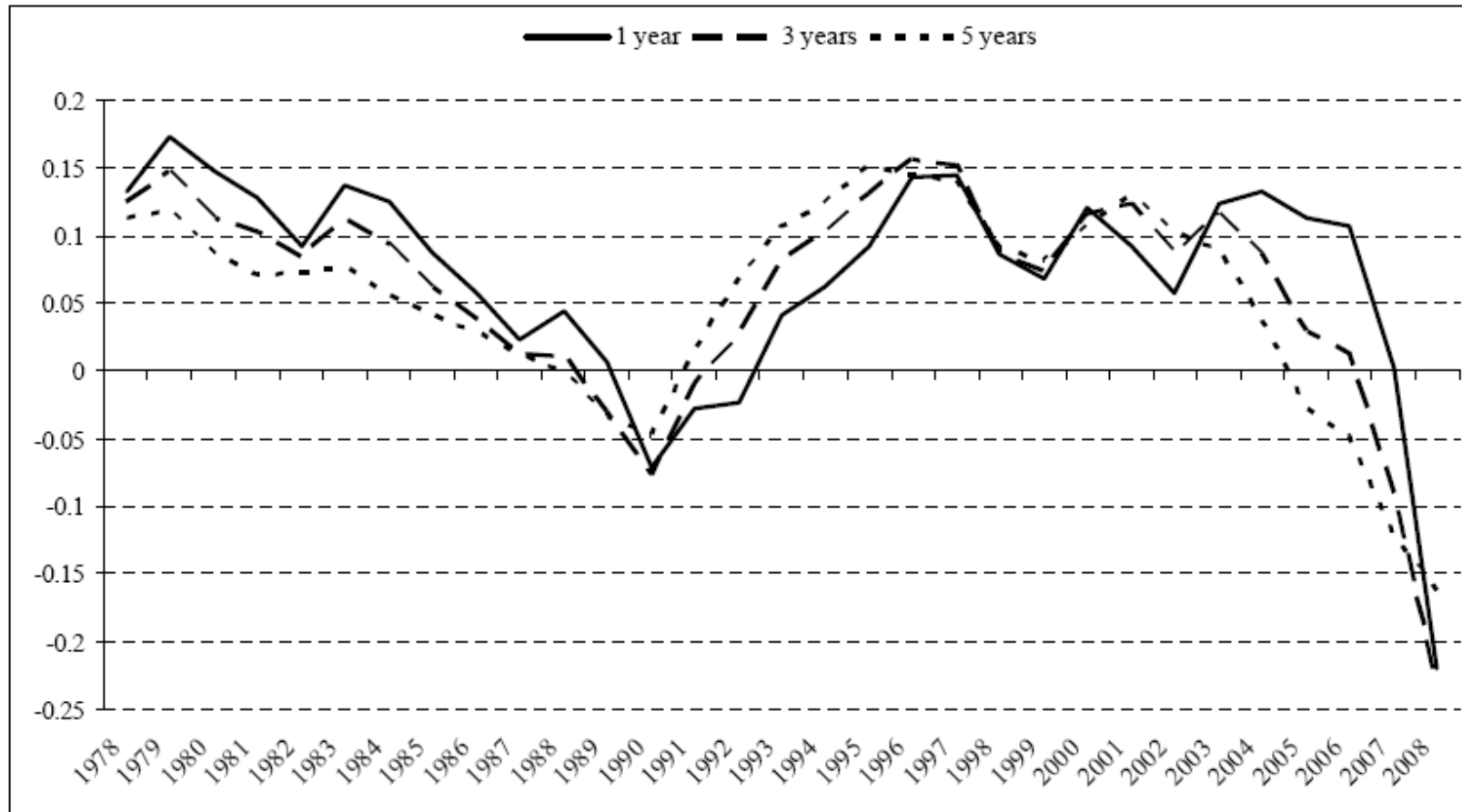
This figure shows fair swap prices with maturity of one, three, and five years, based on the VAR results.

Panel A: UK

	1 year	2 years	3 years	4 years	5 years
Mean	9.40%	9.36%	9.40%	9.47%	9.53%
Standard deviation	7.73%	5.96%	4.66%	3.62%	2.88%
Autocorrelation	44.75%	55.09%	56.88%	57.12%	57.62%
Minimum	-8.71%	-5.18%	-2.77%	-0.04%	2.06%
Maximum	28.66%	22.93%	18.48%	16.87%	15.75%

Panel B: US

	1 year	2 years	3 years	4 years	5 years
Mean	7.09%	6.49%	5.95%	5.52%	5.23%
Standard deviation	8.00%	8.24%	8.31%	8.14%	7.70%
Autocorrelation	69.77%	77.83%	84.48%	88.87%	91.19%
Minimum	-22.01%	-23.74%	-23.08%	-20.41%	-16.34%
Maximum	17.25%	16.09%	15.66%	15.32%	15.19%

This table shows statistics of fair swap prices, based on the VAR estimates.
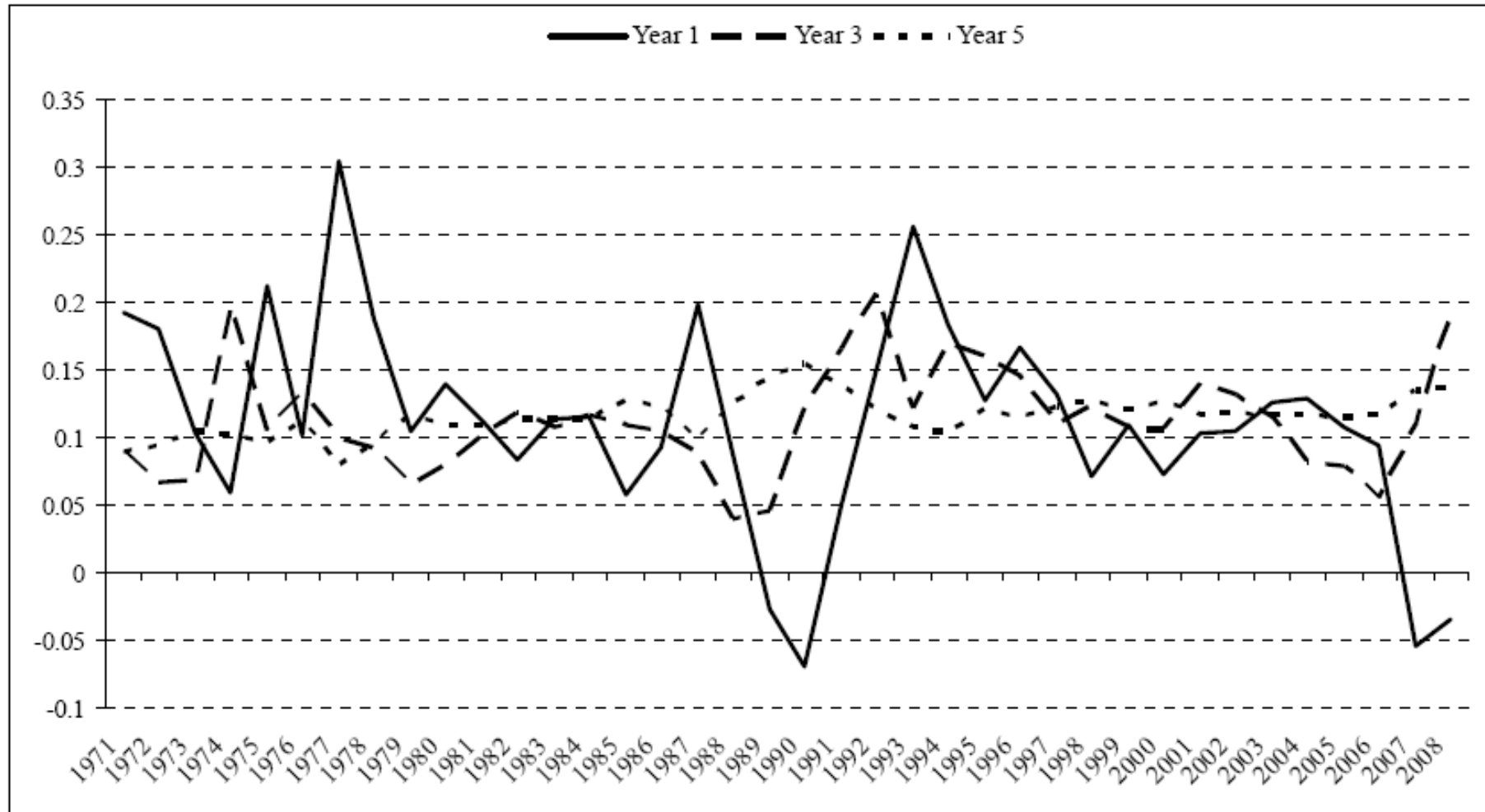
Actual versus modeled swap prices in the UK
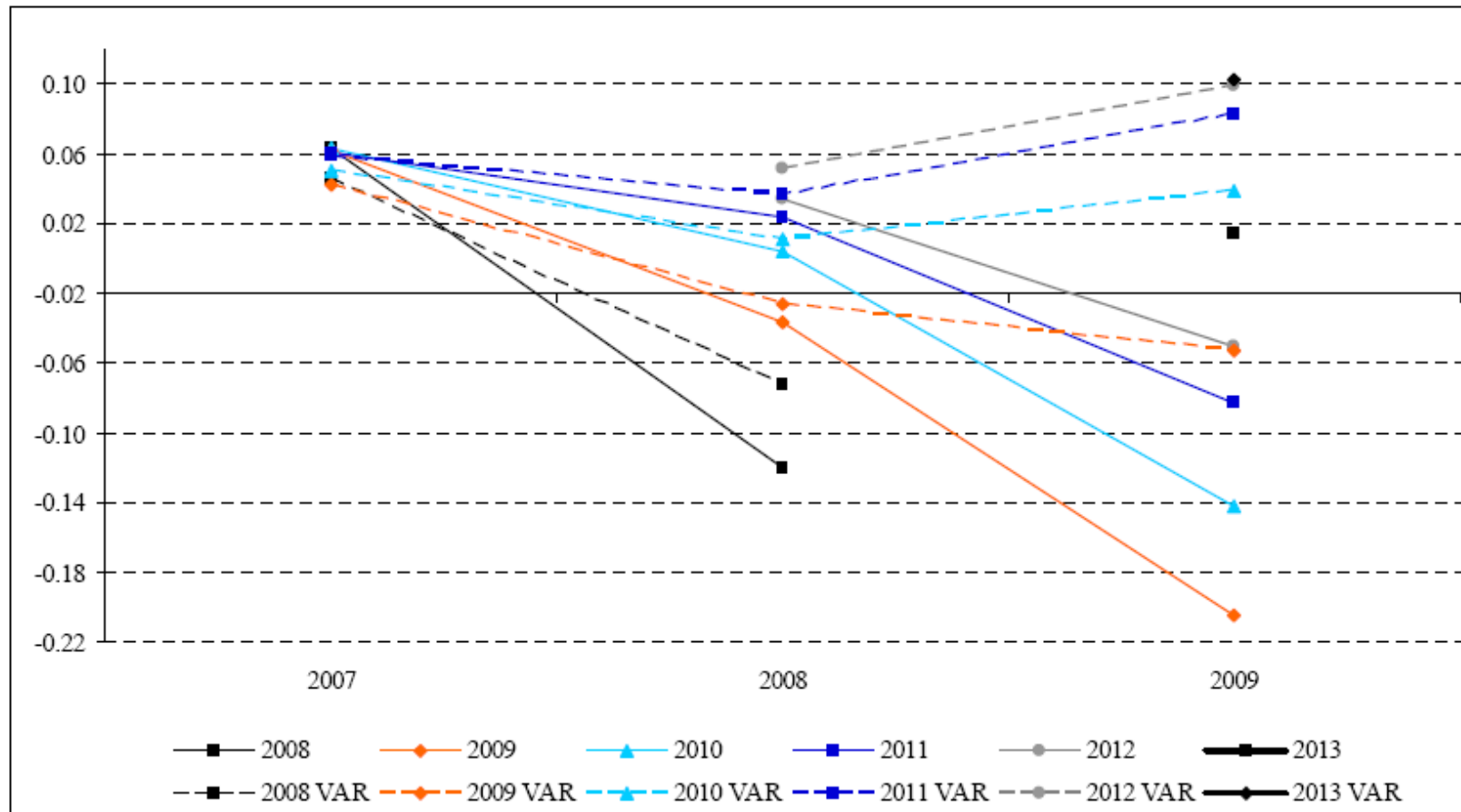
This figure shows actual prices of swaps with different maturity dates, as of the beginning of a year (solid lines), and the corresponding fair swap prices obtained from the VAR results (dashed lines).
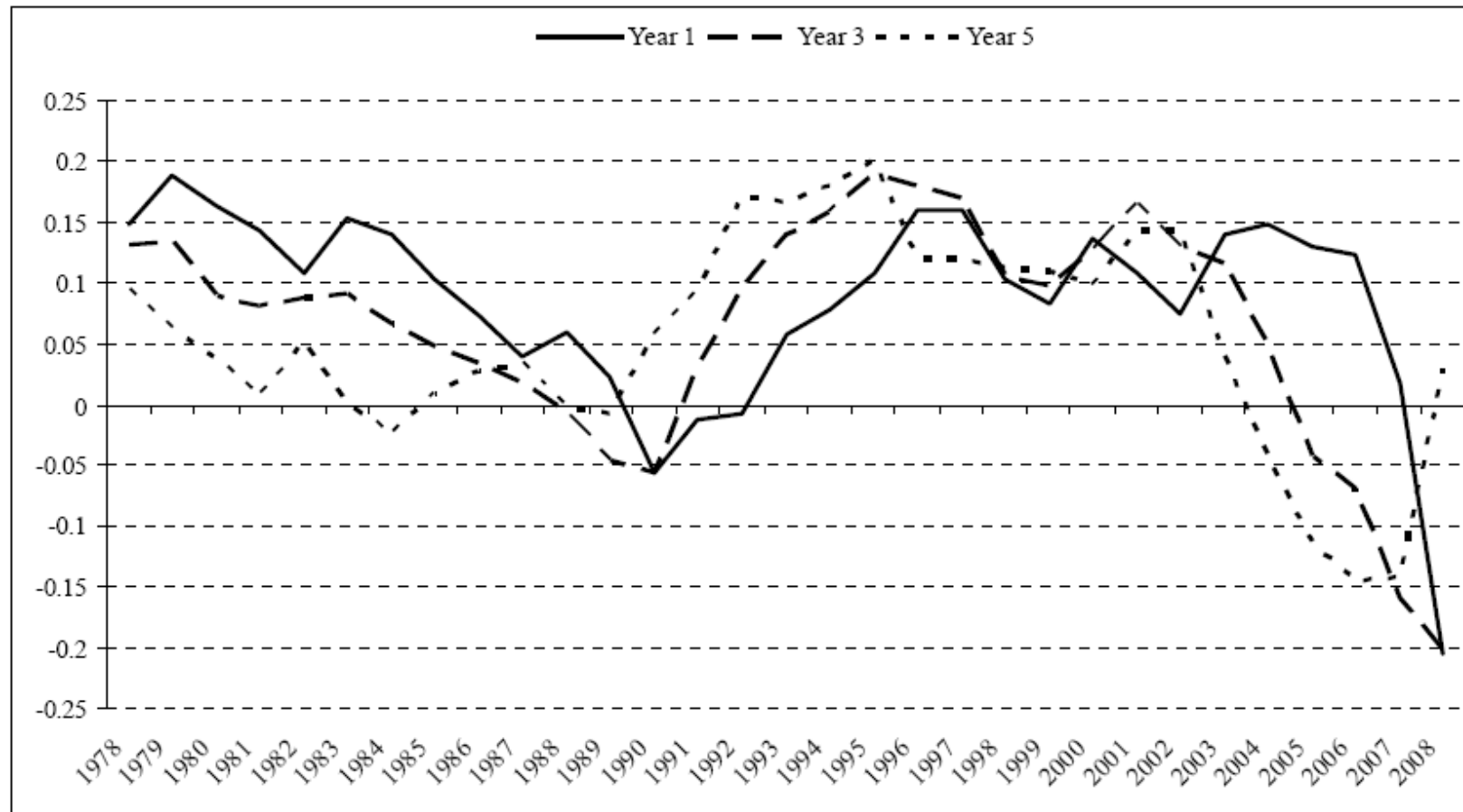
Discussion

Appendix

Forecasts obtained from VAR approach: UK

This figure shows one-, three-, and five-year ahead index return forecasts, based on the VAR results.

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The tables show the coefficients for the UK VAR (Panel A) and the US VAR (Panel B). The results are based on annual data from 1971 to 2008 (UK), and from 1979 to 2008 (US), respectively. The t-statistics are in square brackets; values corresponding to p-values of 10% or below are highlighted. The rightmost column contains the $R2$ values and the p-value of the F-test of joint significance in parentheses.

Panel A: UK

Variable	Constant	Coefficients on Lagged Variables				$R^2 (p)$
		1	2	3	4	
1 Appraisal-based index return	-0.121	0.589	0.033	2.345	2.516	39.46%
	[-1.112]	**[2.441]**	[0.513]	[1.557]	**[2.925]**	(0.24%)
2 Return on property shares	-0.26	0.16	-0.264	6.293	6.513	24.97%
	[-0.749]	[0.209]	[-1.294]	[1.318]	**[2.388]**	(5.04%)
3 Cap rate	0.029	-0.034	-0.005	0.644	-0.191	77.00%
	[3.699]	**[-1.997]**	[-0.994]	**[6.060]**	**[-3.153]**	(0.00%)
4 Yield spread	0.014	-0.023	-0.02	-0.088	0.503	36.34%
	[0.757]	[-0.537]	**[-1.826]**	[-0.335]	**[3.357]**	(0.50%)

Panel B: US

Variable	Constant	Coefficients on Lagged Variables				$R^2 (p)$
		1	2	3	4	
1 Appraisal-based index return	-0.253	0.955	0.172	2.785	0.663	77.61%
	[-4.172]	**[7.182]**	**[4.143]**	**[4.025]**	[1.295]	(0.00%)
2 Return on REITs	-0.508	0.37	0.087	7.156	2.843	19.64%
	[-1.633]	[0.543]	[0.407]	**[2.018]**	[1.084]	(22.46%)
3 Cap rate	0.015	-0.046	-0.011	0.891	-0.081	88.45%
	[2.259]	**[-3.124]**	**[-2.411]**	**[11.564]**	[-1.418]	(0.00%)
4 Yield spread	0.041	-0.092	0.005	-0.264	0.248	28.84%
	[1.727]	**[-1.767]**	[0.336]	[-0.972]	[1.234]	(6.55%)