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REPORT

Liquidity Pricing of Illiquid Assets

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Foreword

So far the main body of the asset pricing literature has computed liquidity risk premia for either markets or single assets. The vast majority of these studies have been focused on fairly liquid assets, but recently a greater attempt to price such an important component of the asset pricing factors in markets with high illiquidity (especially in real estate) has also started to take place.

The present paper brings these recent studies together, and estimates the liquidity premium of illiquid assets looking at three main sources – time on market, liquidation bias and market illiquidity – using three main empirical estimation models and several liquidity measures suggested in the literature. Strong evidence is found of a high premium that varies across sectors and periods. This estimation is robust to different measures of illiquidity and model specifications.

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Liquidity Pricing of Illiquid Assets

1. INTRODUCTION

Several studies have looked at the pricing of some liquidity drivers within real estate markets. Establishing the extent of such an important factor is key to explaining (even though only partially) the equity risk premium puzzle of real estate. In fact, a high return to risk profile makes this asset appealing for asset allocation choices but very few fund managers allocate more than 5%-10% to real estate. This fact would suggest that other features are considered by asset allocators when they decide how to distribute their investments. Secondly, the target rate of return (and, hence, premium) for real estate assets is time-varying and one of the drivers of such variation could be explained by the variation in liquidity available in the market.

In this study, an empirical analysis is provided where, firstly, several liquidity proxies are computed that can be used to measure the liquidity premium. Along with publicly available portfolio metrics of the transaction activity within such markets (e.g. transaction volumes, turnover rates), some measures suggested in broader finance literature are also computed (Amihud, 2002; Roll, 1984; Pastor and Stambaugh, 2003). The author believes that such measures – along with Time on Market (TOM) presented in a previous paper[1] – capture different dimensions of the liquidity phenomenon: tightness, depth, breadth, immediacy, resilience.

Secondly, the analysis is presented using three different models to assess the ex-ante risk-return impact of liquidity premia for illiquid assets: time on market, which leads to an underestimation of the ex-ante risk varying in both holding period and time on market; liquidation bias, which leads to an overestimation of the return because only accepted bid prices (highest ones) are observed in transaction data and market illiquidity, which requires an extra return to compensate the investor for the exposure of assets to movements in liquidity levels recorded within their markets.

As a final step of this study, the author empirically uses these models to compute the liquidity premium to be embedded in the estimation of both ex-ante return and ex-ante risk for the UK real estate market. This empirical application is new for two main reasons: first it brings the estimation of several sources of liquidity together in one study allowing a comparison of the impact of such sources in determining the overall liquidity premium; second, it applies some of these models for the first time to the UK market, which offers by far the best databank of real estate assets under performance measurement – i.e. the transaction data refer to the properties whose performance is measured and they also reflect a good proportion of overall transactions taking place in the market. Thirdly, an ex-ante perspective and estimation are offered that can be compared to an ex-post analysis previously presented in the literature and suggesting an overall risk premium of real estate assets of around 2-4%.

The paper is structured as follows: the next section presents the main theoretical models and the relevant literature not been covered in the Literature Review[2]. To allow the reader to focus on intuitions and results, the main derivation of models are included in the Appendix. Section 3 describes the data used in this study and particularly the main measures of market liquidity used in estimation. Finally, Sections 4 and 5 respectively discuss the main empirical results and conclude the paper.

[1] Devaney S. and Scofield D. (2014): "Time to Transact: Measurement and Drivers".

[2] Ametefe F., Devaney S. and Marcata G. (2014): "Estimating Liquidity in Asset Markets - Literature Review".

2. MODEL AND METHODOLOGY

In this section, three main models are presented, which are helpful to understand the impact of liquidity on ex-ante measures of risk and return. In fact, when investors price the liquidity factor, their perceived risk attached to the investment (i.e. estimated ex-ante volatility) may be higher due to the presence of such risk factor. The first model captures this dynamic estimating the new ex-ante volatility for investors pricing the time necessary to transact their assets (i.e. time on market). The previous IPF report, Time to Transact: Measurement and Drivers (2014) by Devaney and Scofield, incorporated estimates of TOM for different types of properties and during different periods. The model utilises this information to estimate what extra risk investors expect if they cannot transact their properties instantaneously, as for financial markets such as equities and bonds.

Moreover, since properties are not transacted frequently and, at any point in time, transaction prices are only observed for a restricted sample of investable properties (i.e. not all properties are transacted at every point in time), investors may require a higher return because they want to be rewarded for the risk of not being able to sell their assets (or of needing to sell their assets at a discount) when they are in a position to do so. Hence, considering the impact of a liquidation bias, investors will increase the ex-ante return they require when they invest in real estate assets.

Finally, the third model also looks at the greater or smaller ability of a market to absorb order flows without affecting prices (i.e. matching demand and supply of transacted properties). In periods when markets are not able to absorb order imbalances, higher than expected price movements can be recorded. As a consequence, investors want to be paid for this extra risk and they ask for a higher ex-ante return.

The following three sections (2.1, 2.2 and 2.3) present the three different models in reference to the related literature and give an intuition about their interpretation and application. The reader interested in understanding the derivation and application of models in more depth should refer to the Appendix.

2.1 TOM, Risk and Return

The first model empirically estimated assesses the impact of the TOM on the ex-ante risk of real estate. An objective is to build on the evidence given in Devaney and Scofield's Time to Transact: Measurement and Drivers (2014), where a thorough data collection managed to achieve a sample of observable transactions. This evidence is used to determine the impact of TOM on the risk/return profile of real estate assets. Hence, the stream of literature is followed that theoretically models the ex-ante risk and return adjusting the ex-post measures. Particularly, Cheng et al. (2010, 2013), Lin and Vandell (2007), Bond et al. (2007), Lin and Liu (2008) and Lin et al. (2009) are followed and the models empirically tested to compute a new measure of risk, either assuming random real estate returns or deviating from this assumption.

Cheng et al. (2013) build a simple model, based on the transaction process of real estate assets, where, in a round-trip transaction (i.e. buy, hold and sell), an investor faces the uncertainty of time on market (i.e. time to sell the asset) coupled with the uncertainty of the price achieved for the successful sale. As a result of this process, the ex-ante return is a function of both variables: on one hand, the longer the TOM the higher the ex-ante return is, because the liquidity premium will depress the price the buyer is willing to pay for the asset; on the other hand, the higher the selling price is, the higher the return is. This feature is different from financial assets where the uncertainty of TOM does not exist because transactions can be executed instantaneously. Hence, this market friction in real estate markets represents a liquidity risk that can be associated with a lower return expected by economic agents in the case that they need to sell quickly due

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to a liquidity constraint.

Consequently, if real estate returns were following a random walk (i.e. they were highly unpredictable because there was no time-dependency) the ex-ante return would simply be equal to the ex-post single-period return (e.g. average annual return from IPD) multiplied by the sum of holding period (*t*) and TOM (t_{TOM}):[3].

Equation 2.1

$$ret_{ex\text{-}ante} = (t + t_{TOM}) * ret$$

And the risk – measured by variance (volatility squared) – would be represented by a combination of variances of returns within the holding period and variance of TOM (respectively σ_t^2 and σ_{TOM}^2) as follows:

Equation 2.2

$$\sigma_{ex\text{-}ante} = (t + t_{TOM})\sigma_t^2 + ret * \sigma_{TOM}^2$$

Clearly, if TOM is equal to zero (as for financial assets), the second term of the equation disappears and the ex-ante variance is equal to the single-period variance (σ_t^2) multiplied by the holding period (*t*).

If 10% and 8% are assumed as being the annual ex-post single period return and standard deviation of real estate respectively, Table 2.1 reports ex-ante adjusted estimates of annual standard deviations for an investor considering the effect of TOM. Clearly, as the TOM increases, the ex-ante risk increases because it now includes the uncertainty about the time needed to sell the asset. For example, for a 5-year holding period, the ex-ante risk perceived by the investor should pass from 8.0% (assuming TOM = 0) to 9.4% when the time on market is 15 months (i.e. 1.4% difference). The marginal effect on the ex-ante risk is also smaller for longer holding periods (HPs) because the risk associated to TOM can be absorbed throughout the length of a longer investment period. In fact the effect on an increase of TOM from 0 to 15 months for a 15-year HP 'only' increases the ex-ante volatility from 8.0% to 8.6% (i.e. difference of 0.6%). In other words, the TOM (in the example of 15 months) has a bigger relative impact on the annualised 5-year holding period volatility (rising to 9.4%) than on the annualised 15-year holding period volatility (which only increases to 8.6%).

As a result of this 'extra' risk being considered – i.e. in the example the difference between the new ex-ante volatility minus the ex-post one of 8% – should lead to a higher ex-ante return required by the investor as a compensation for a higher risk. As a crude measure of the ex-ante return, the same ratio of modified versus original standard deviation could be applied to the original return. Returning to the example of an investor with 5-year holding period, the ratio of the two standard deviations would be 1.175 for a TOM equal to 15 months (9.4% divided by 8.0%). Hence, assuming an originally estimated return of 10% without considering the effect of the TOM, investors should require a slightly higher ex-ante return of around 11.75% (10% multiplied by the ratio 1.175) if they also want to consider the uncertainty of not being able to sell the property immediately (i.e. TOM = 15 months). The new figures (9.4% and 11.75%) would then represent the ex-ante risk and return profile of the investment when the effect of TOM is also considered.

[3] For financial assets with TOM equal to zero, the single-period return would only be multiplied by the holding period.

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Table 2.1: Illustration of the Effect of TOM on Risk Assuming Returns are a Random Walk

	t	5	8	10	12	15
t_{TOM} (in months)	0	8.0%	8.0%	8.0%	8.0%	8.0%
	3	8.1%	8.0%	8.0%	8.0%	8.0%
	6	8.3%	8.2%	8.1%	8.1%	8.1%
	9	8.6%	8.4%	8.3%	8.3%	8.2%
	12	9.0%	8.7%	8.5%	8.5%	8.4%
	15	9.4%	9.0%	8.8%	8.7%	8.6%

Note: The table reports the ex-ante standard deviation associated to different measure of holding period (HP, measured in years) and time on market (TOM, measured in months) when it is assumed that returns are independently distributed (no issues of smoothing at index level). Assuming a volatility of 8% with TOM equal to zero (first row), as TOM increases, the ex-ante risk increases because it includes the uncertainty about the time needed to sell the asset. The marginal increase is smaller for longer holding periods (i.e. the effect of 6 months TOM is bigger for an investor with a 5-year HP than for an investor with 15-year holding period).

Previous literature – Geltner (1989), Booth and Marcato (2004) and Bond et al. (2012) among others – has shown evidence of serial correlation (smoothing) in both residential and commercial markets and hence the assumption of intertemporal independence of return distributions is invalidated. In other words, it has to be considered that real estate markets are cyclical and that part of the cyclicality may be due to the use of appraisal-based (rather than transaction-based) indices. One way to approach this issue would be the creation of a version of the appraisal-based index corrected for smoothing. However, the extent to which the original index should be unsmoothed is not deterministic and, hence, one would be left in the uncertainty domain as to the statistical adequacy of such correction – see Key and Marcato (2007) for a study of the implications on asset allocation choices.

Hence, the work by Cheng et al. (2013) is followed, who developed an estimate of the ex-ante risk, correcting for both smoothing and the time on market. The intuition behind their model is that without smoothing the computation of risk (measured as standard deviation) for different investment horizons should give a measure that is increasing as time increases, i.e. the risk of investing for 5 years should be smaller than the risk of investing for 10 years. At the same time, the impact of illiquidity (measured as TOM) on the overall risk mitigates this effect because, as the holding period increases, the marginal impact of the TOM decreases (as already shown in Table 2.1).

Table 2.2: Illustration of the Effect of TOM on Risk Not Assuming a Random Walk

	t	5	8	10	12	15
t_{TOM} (in months)	0	11.2%	13.3%	14.6%	15.8%	17.4%
	3	11.4%	13.5%	14.8%	15.9%	17.5%
	6	11.8%	13.8%	15.0%	16.1%	17.7%
	9	12.2%	14.1%	15.3%	16.4%	17.9%
	12	12.7%	14.4%	15.5%	16.6%	18.1%
	15	13.3%	14.8%	15.9%	16.9%	18.3%

Note: The table reports the ex-ante standard deviation adjusted by liquidity and violation of random walk assumption. For example, for a 10-year holding period and 12-month TOM, the ex-ante standard deviation is 15.5%, compared to 14.6% if TOM were equal to zero (and assuming the same investment horizon). TOM represents time on market measured in number of months, while *t* indicates the investment horizon in years.

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Applying the Cheng et al. (2013) model – see Appendix 1 for further discussion – results are presented in Table 2.2, which shows the modified ex-ante standard deviation if both the TOM and correct returns for smoothing are considered. Firstly, the ex-ante risk is around 11% (for an investor with five-year holding period) if returns are only corrected for smoothing and the time on market is equal to zero. As TOM increases, the ex-ante volatility increases from 11.2%to 13.3% (i.e. 2.1% difference) for a five year holding period and from 17.4% to 18.3% (i.e. 0.9% difference) for a 15-year investment horizon. Overall, the ex-ante risk reported in Table 2.2 is bigger than the one shown in Table 2.1, mainly due to the correction for smoothing introduced using the Cheng et al. (2013) model rather than the Lin and Vandell (2007) model. This finding is important because it shows that smoothing (non-randomness) causes an underestimation, not only of the total risk of real estate investment, but also of the impact of TOM on the ex-ante risk. In fact, for a short investment horizon (5 years, first column) the difference of ex-ante risk (between a market where TOM is equal to zero and another where it is equal to 15 months) is 2.1% rather than 1.4% (as in Table 2.1). For a long investment horizon (15 years, last columns), instead, the difference is 0.9% rather than 0.6%.

2.2 Liquidation Bias

After a discussion about the impact of TOM on the ex-ante risk associated with real estate investment, another potential factor can be considered, causing a deviation of ex-ante returns (i.e. return expected by the investor before the investment is made) from ex-post ones. Lin and Vandell (2007) are followed to model the so-called liquidation bias, which reflects the inability of investors to sell their assets at observed market prices immediately, as happens in financial markets. The evidence of this bias is represented by the low turnover and small portion of properties sold successfully, with many other properties sitting on the books of funds and either being offered to the market but not transacted (because a counterparty is not found or a price is not agreed) or not being offered to the market because the seller does not believe that a 'reasonable' price would be achieved.

Firstly, this bias is important for transaction-based indices because the observed prices are only reflecting the information on successful transactions (which may have different characteristics from the ones of unsuccessful transactions). Hence, returns only reflect the characteristics of a sub-sample of all potentially transacted properties (the ones that are actually transacted). Secondly, this bias is also relevant for valuation-based indices because appraisals used to construct valuation-based indices derive from comparables of transacted properties (and not from the full set of information of properties that may be potentially transacted). Finally, the liquidation bias also relates to the evidence that transacted properties may have been up for sale for a longer time than the measured TOM – an issue, which is also related to the relisting phenomenon in housing markets.

Evidently, this bias would cause an overestimation of returns because the sub-sample of sold properties normally shows a price above the expected bid price at any point in time (i.e. the selling price will always have to be higher than the seller's reservation price, which is the minimum price a seller would accept to execute a transaction). Moreover, for any observed sale price, a significant time lag is recorded between the time when a property is included in the trading portfolio (ready to be sold) and when the same property is actually transacted. Hence, the liquidation bias may be thought of as representing the impact that the sudden to sell a property may have on the pricing of real estate assets. This effect can be translated into a reduced ex-ante return due to the potential sale price discount when this risk is considered.

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Table 2.3: Liquidation Bias
Panel A: Ex-ante Return

t_{TOM} (in months)	t	5	8	10	12	15
	0	10.0%	10.0%	10.0%	10.0%	10.0%
	3	8.5%	8.8%	8.9%	9.0%	9.1%
	6	7.0%	7.6%	7.9%	8.0%	8.2%
	9	5.7%	6.5%	6.8%	7.1%	7.4%
	12	4.3%	5.4%	5.8%	6.2%	6.5%
	15	3.1%	4.3%	4.8%	5.2%	5.7%

Panel B: Standard Deviation

t_{TOM} (in months)	t	5	8	10	12	15
	0	8.0%	8.0%	8.0%	8.0%	8.0%
	3	9.5%	9.7%	9.8%	9.8%	9.8%
	6	10.9%	11.3%	11.4%	11.5%	11.6%
	9	12.2%	12.8%	13.0%	13.2%	13.3%
	12	13.3%	14.2%	14.5%	14.8%	15.0%
	15	14.4%	15.6%	16.0%	16.3%	16.6%

Note: The table reports the ex-ante return (Panel A) and standard deviation (Panel B) when the liquidation bias is considered. The liquidation premium is computed by taking the difference between ex-post and ex-ante return. TOM represents time on market measured in number of months, while *t* indicates the investment horizon in years.

As an illustrative example, assuming – as before – that the annual ex-post return and standard deviation are equal to 10% and 8% respectively. Table 2.3 reports the ex-ante return (Panel A) and volatility (Panel B) for a series of combinations of marketing time and holding period applying the Lin and Vandell (2007) model to correct for the liquidation bias. As the marketing time increases, the expected ex-ante return decreases because the sale price may be lower than expected due to the discount investors may incur. The difference between the original return (10%) and the newly computed (liquidation-adjusted) one represents the premium associated with the liquidation bias. As an illustration, for an investment horizon of 10 years and marketing time of nine months, the average return of 6.8% suggests a liquidation premium of 3.2% (difference between 10% and 6.8%). Since the impact of the liquidation bias on returns decreases as the holding period increases, it is also found that the premium is smaller for long investment horizons than for short ones (i.e. the impact of the sale price discount is spread across more years). Finally, Panel B shows the impact of the liquidation bias on the ex-ante volatility. Considering the risk of a price discount in the sale proceeds, an increase in risk is recorded as both marketing time and holding period increase, with the former having a bigger marginal impact than the latter.

2.3 Market Liquidity

Several models have previously attempted to price different risk factors jointly to capture the net impact of variations in liquidity levels on actual price movements and subsequently estimate the ex-ante liquidity risk premium. Within this framework, a smaller market liquidity premium represents the greater ease of finding

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counterparties to exchange assets at a specific point in time. The estimation of such models is very useful because it can also capture the time-varying nature of risk premia using market-wide information that is available to all investors – unlike the average and standard deviation of TOM. For financial assets such as bonds and equities, a series of asset pricing studies on liquidity have been published. Among them, Fama and French (1993), Carhart (1997) and Pastor and Stambaugh (2003) are combined to estimate a model that prices liquidity along with other risk factors. The inclusion of other factors that are not related to liquidity is important in order to isolate the illiquidity risk premium and obtain an estimate that does not include other sources of reward. Alongside illiquidity, according to standard finance literature, four main factors are included:

- market beta ($RMRF_t$), which represents the market premium and reflects the sensitivity of the asset to market movements, i.e. systematic risk. This risk represents the amount of risk that the investor cannot diversify away;
- size (SMB_t) – spread between returns of small- and large-sized firms – which represents the "small-firm effect" due to smaller firms outperforming large ones. It captures the loading on the extra risk attached to smaller businesses, which tend to be more volatile than bigger companies;
- value/growth (HML_t) – spread between returns of value and growth stocks – which captures the outperformance of value assets (high book-to-market ratio) on growth assets (low book-to-market). This factor has also been found significant for properties, with Jones Lang LaSalle now producing separate indices for value and growth properties (i.e. buildings with high income vs. properties with high potential growth) – Marcato (2004);
- momentum (UMD_t) – spread between returns of highest and lowest performing firms, lagged one month – which was introduced by Carhart (1997) to correct for the tendency of asset prices to show a degree of serial correlation (succession of returns above/below the average). This factor seems even more important for real assets than for financial ones.

The five-factor model developed by Pastor and Stambaugh (2003), used in this part of the study, can be represented as follows:

Equation 2.3

$$ret_t = \alpha + \beta_1 MKT_t + \beta_2 SMB_t + \beta_3 HML_t + \beta_4 UMD_t + \beta_5 LIQ_t + \varepsilon_t$$

where β_1 to β_5 are the estimated coefficients for the five risk factors in the asset pricing model. As a measure of liquidity, Pastor and Stambaugh (2003) suggest transaction volumes, with the sign being positive if the lagged excess market return is positive and negative otherwise. They focus on the aspect of liquidity capturing the link between temporary price changes and order flow. The simple intuition is based on Campbell et al. (1993) who argue that volume-related returns are caused by liquidity and the greater the order flow, the greater the compensation on future returns should be. The sign attached to the volumes is introduced because order flows "should be accompanied by a return that one expects to be partially reversed in the future if the stock is not perfectly liquid".

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In the author's estimation, the Pastor and Stambaugh (2003) liquidity measure is slightly modified using volumes with the sign being positive if the lagged real estate return is above the risk-free rate (rather than market return). The rationale behind this choice is the fact that real estate investors do not adjust their positions instantaneously whenever the asset return is below/above the market return, but when there is major news that may lead to returns falling below the risk-free rate. Due to the presence of serial correlation in real estate returns, this liquidity measure tends to have the same sign of the left-hand side variable (excess real estate return). Hence, a positive estimated coefficient is expected as a result. Alongside this measure (PS from now onwards), the model is also estimated using several other liquidity proxies suggested in the literature and presented in the next section. Normally, positive estimated coefficients are expected when the measure reflects a liquidity proxy and negative ones when the measure refers to illiquidity.

3. DATA DESCRIPTION AND MARKET LIQUIDITY MEASURES

In this study, the pricing of liquidity in the UK real estate market is analysed. The IPD database is used, which contains information on performance measures and transaction activity of a large part of the investable UK universe, going back to December 1980 with an annual frequency and to December 1986 with a monthly frequency. Particularly in the annual database, IPD covers 291 funds investing in 21,175 properties with a value of £ 152.6 billion as at December 2013. The three main sectors are retail (46.8%), office (26.5%) and industrial (15.4%). Part of these properties are also valued monthly and form the monthly database, which is made by 58 funds investing in 3,407 properties with a total value of £35.5 billion as at December 2013. The proportion of sectors is similar and, respectively, equal to 43.9%, 31.8% and 18.7%.

In this study, both databases are used, depending upon the analysis needed. If annual figures are needed, the annual database is directly used. For estimations of the third model (Pastor and Stambaugh,2003), a monthly frequency tends to be used instead, to match studies in other asset classes and to increase the statistical power of the results).

A comparison of the main descriptive statistics for the two databases is reported in Table 3.1. Panel A shows that the annual average return is 9.45% for the overall market and ranges between 8.78% and 10.41% for the different sectors. The volatility is around 10% whilst the return distribution is slightly negatively skewed. Annualised monthly figures are reported in Panel B, which shows slightly smaller returns and higher single-period swings (i.e. jumps in single months, as suggested by high absolute values for minimum and maximum figures). The main difference is represented by volatility, which tends to be underestimated using a monthly frequency. This feature is important because the findings using the annual database are different in magnitude from previous US studies. The author argues that the direct use of annual performance for volatility measures is more appropriate and, hence, the impact of liquidity results is less prominent than it would be otherwise. In other words, if volatility is underestimated due to the monthly/quarterly data frequency, the risk premium puzzle (and, hence, the liquidity premium) may appear even more significant than it is in reality.

Table 3.2: Descriptive Statistics
Panel A: Annual figures (Source: IPD Annual Database)

	All Property	Retail	Office	Industrial
Mean	9.45%	10.12%	8.78%	10.41%
Median	10.24%	12.01%	8.35%	10.52%
Standard Deviation	10.03%	9.56%	11.34%	10.65%
Kurtosis	2.3	3.4	1.1	2.7
Skewness	-0.9	-1.5	-0.5	-0.1
Minimum	-22.10%	-22.56%	-22.41%	-21.21%
Maximum	29.51%	24.85%	31.14%	39.31%

3. DATA DESCRIPTION AND MARKET LIQUIDITY MEASURES

Table 3.2 Continued
Panel B: Annualised monthly figures (Source: IPD Monthly)

	All Property	Retail	Office	Industrial
Mean	8.68%	8.41%	8.08%	10.50%
Median	9.43%	9.14%	9.16%	10.53%
Standard Deviation	3.88%	3.97%	4.23%	3.82%
Kurtosis	6.5	7.6	4.6	5.1
Skewness	-1.6	-1.7	-1.3	-0.9
Minimum	-47.76%	-51.02%	-48.01%	-44.90%
Maximum	53.53%	64.36%	56.64%	75.94%

Note: Annualised figures are obtained by compounding monthly figures by 12 months. Annualised standard deviation is monthly standard deviation multiplied by √12.

Since a model that formally accounts for serial correlation in the data is used to obtain the ex-ante return, annualised figures of standard deviation already corrected for smoothing issues[4], are not reported to avoid double counting. Moreover, serial correlation is still found in the return series with annual frequency. Hence, the extent of the correction will be measured on the basis of the amount of smoothing found in annual data.

The risk-free rate is represented by the redemption yield of the 10-year benchmark of UK Government Gilt Index, while the equity factors of the model are taken from Gregory et al. (2013).

In this section, some measures of market liquidity are also computed that are used to estimate the liquidity premium from the last model presented above. Particularly, a focus is applied to measures using data that are publicly available in real estate markets. This has the advantage of offering a snapshot of different liquidity proxies that can be reproduced and updated by the reader at any point in time. All volume-related measures trending in time have also been normalised by using the inverse of the IPD capital value index (i.e. volumes have been used at current values).

Trading Volumes

Trading volume is an indirect but widely cited measure of market liquidity because of its simplicity and availability, with volume figures regularly reported for most assets. This measure indicates the amount of transaction activities over time. In periods with high volumes, a greater ability to sell properties is expected and, hence, a reduced liquidity premium. Transaction volumes are comouted for a given period t (i.e. the dollar volume traded Vol_t) as the sum of individual i trades within the period (computed as prices P_{it} times quantities Q_{it}):

Equation 3.1

$$Vol_t = \sum_{i=1}^{n} P_{it} Q_{it}$$

In this exercise, volumes are computed as the sum of purchases and sales as recorded in the IPD database – see Ling et al. (2009) for a discussion of shortcomings in using this measure.

[4] Using the correction for autocorrelation, the annualised standard deviation would be approx. 30% bigger than the unadjusted one.

3. DATA DESCRIPTION AND MARKET LIQUIDITY MEASURES

Turnover Rates

Turnover gives an indication of the number of times the outstanding volume of an asset changes hands within a specified time period and it is found to be negatively related to illiquidity costs (Amihud and Mendelson, 1986) because market makers tend to charge a higher transaction cost to cover the risk of holding their position when the turnover ratio is low. The inverse of this measure also gives an indication of the average holding period for the asset. Turnover is computed as follows:

Equation 3.2

$$Turn_t = \frac{Vol_t}{\sum_{i=1}^{n} P_{it} S_{it}}$$

where S_{it} is the number of outstanding assets and P_{it} and Vol_t represent respectively the average price of the i trades and the trading volumes computed in the previous liquidity measure.

In this modelling exercise, the denominator of the equation is measured by the value of the stock monitored by IPD rather than by the total market size because this measure is needed on a periodical basis (every month). Clearly, this measure using IPD data reveals the turnover ratio of institutional investors (dominating players in the database) and not necessarily the one of the overall market.

Net Flows

Previous studies have shown the importance of the direction of investment flows, along with their quantity. In other words, if there are greater imbalances in order flows, the price pressure (and hence illiquidity) may increase. In fact, for a player on the 'wrong side' of the transaction (i.e. the one with very many competing players) a prompt matching with an opposite counterparty may prove to be difficult. The measure of net flows is computed as the difference between actual investments (purchases) and disinvestments (sales) in the market. Following Ling et al. 2003, it is recognised, if there were 100% market coverage, net flows would clearly be equal to 0 (accounting for transactions only, there must always be two opposite counterparties). Over the last decade at least, the entry of non-domestic investors in particular segments of the market (e.g. London Offices) has been observed and this may have altered the overall amount of net flows to real estate investments. However, since the IPD database shows a very high coverage of institutional players[5], it may be argued that these imbalances reflect the extent to which institutional investors (risk-averse and liquidity lovers) decide to increase (positive net flows) or reduce (negative) their exposure to real estate. As a consequence, the negative value of this measure represents the extent to which more opportunistic players (e.g. hedge funds and private equity funds) may enter the market to exploit periods of liquidity dry-out. Net flows are computed as the difference between purchases and sales, divided by transaction volumes (calculated as the sum of purchases and sales):

Equation 3.3

$$NetFlows_t = \frac{Purch_t - Sales_t}{Vol_t}$$

[5] At the present time, mainly domestic institutional investors.

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Amihud Measure

The Amihud (2002) measure identifies the price impact of transaction volumes (i.e. the higher the measure the lower the liquidity of an asset/market) and it has been widely used in the literature. It represents a proxy of transaction costs – as discussed in Amihud (2002) – for studies looking at long time series and assets for which intra-day market data are not available. By construction, it represents the price pressure on assets: when this measure is low, it means that high transaction volumes do not impact significantly on the price and hence there is high liquidity in the market; vice versa, when its value is high, it means that relatively low volumes have a significant impact on prices and the market liquidity is low. Since a monthly (but not daily) frequency is available for UK real estate data, the original Amihud (2002) measure is modified and computed as the ratio between the absolute value of the monthly return (TR_t) and the monthly transaction volume (Vol_t) as follows:

Equation 3.4

$$Amihud_t = \frac{|TR_t|}{Vol_t}$$

Roll Measure

Roll (1984) developed an implicit measure of the effective bid-ask spread based on the serial covariance of the changes in stock price, with the intuition that an illiquid asset should show a stronger autocorrelation pattern because it violates the two key assumptions of markets being informationally efficient and price changes being stationary. Since the autocorrelation coefficient is normally positive for real estate markets, is modified the Roll measure using the absolute measure of serial covariance, where ΔP_t indicates the price change at time *t* and *cov* refers to the covariance operator:

Equation 3.5

$$Roll_t = 2 \times \sqrt{|cov(\Delta P_t, \Delta P_{t-1})|}$$

Pastor-Stambaugh Liquidity Factor

This liquidity dimension is associated with temporary price changes accompanying order flows. Following Pastor and Stambaugh (2003), a modified version of the signed transaction volumes is used, where transaction volumes are positive if the real estate return is above the risk-free rate and negative if vice versa:

Equation 3.6

$$PS_t = sign(r_t^e) * Vol_t$$

As explained above, the original intuition behind this measure is simple: volume-related returns are caused by liquidity and an increase in the order flow requires a higher compensation on future returns, which are expected to be partially reversed if the asset is not perfectly liquid[6].

[6] See Section 2.3 for further discussion.

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As the original Pastor and Stambaugh (2003) liquidity measure is slightly modified, by construction, this liquidity measure tends to have the same sign as the left-hand side variable (excess real estate market return) and, hence, a positive estimated coefficient is estimated as a result.

Table 3.3: Correlation Coefficients of Liquidity Measures
Panel A: All Property 1988-2012

	Volumes	Turnover	Net Flows	Amihud	Roll	Ret/Turn	PS
Volumes	1.00	0.19	0.42	-0.43	0.12	0.07	0.62
Turnover		1.00	0.40	0.03	-0.16	-0.32	0.34
Net Flows			1.00	-0.14	-0.18	-0.28	0.67
Amihud				1.00	0.08	0.30	-0.32
Roll					1.00	0.54	-0.27
Ret/Turn						1.00	-0.36
PS							1.00

Panel B: All Property 1996-2012

	Volumes	Turnover	Net Flows	Amihud	Roll	Ret/Turn	PS
Volumes	1.00	0.43	0.46	-0.18	0.16	0.04	0.53
Turnover		1.00	0.57	-0.22	-0.32	-0.36	0.51
Net Flows			1.00	-0.30	-0.32	-0.38	0.75
Amihud				1.00	0.52	0.86	-0.40
Roll					1.00	0.60	-0.31
Ret/Turn						1.00	-0.45
PS							1.00

Different measures are computed for the overall market, using the IPD All Property indices, as well as for the three main sectors – Retail, Office and Industrial – making sure that they are not biased simply because of the coverage increase of the IPD database in time and the increase in volumes due to capital growth. Hence, the volume-based measures are corrected, deflating them with the capital value index of IPD over time.

The correlation matrix of the computed liquidity measures is reported in Table 3.3. Panel A shows that for the overall sample period (1987 to 2012) the different measures show some significant correlations with signs according to expectations. Particularly, Amhiud, Roll and Return/Turnover are proxies for illiquidity, while

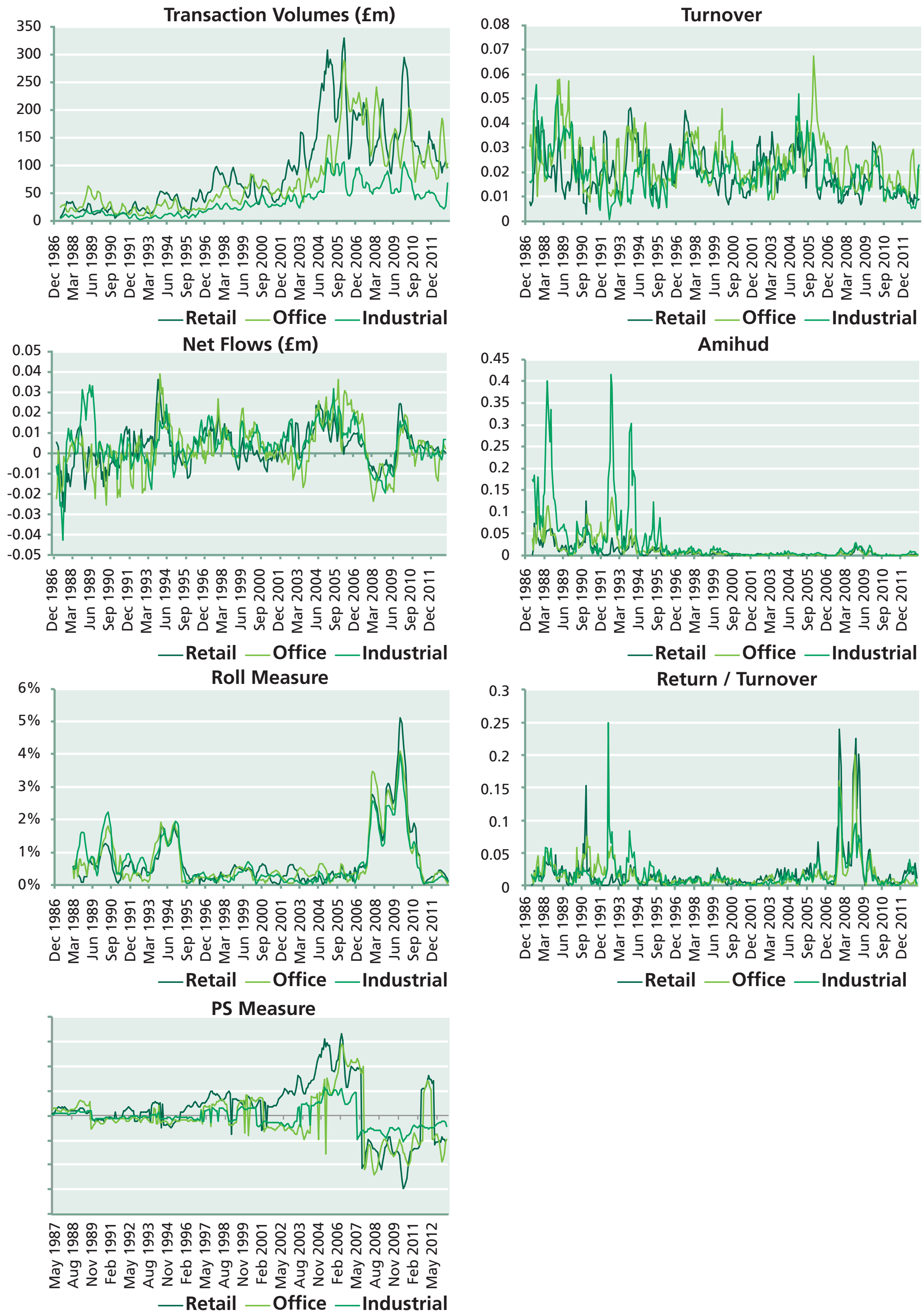
3. DATA DESCRIPTION AND MARKET LIQUIDITY MEASURES

the remaining ones are proxies for liquidity. Accordingly, a negative correlation coefficient is found between these three measures and the remaining ones, with the only exception of transaction volumes (coefficient non-significantly different from zero), which have been already proved to be a weak proxy for liquidity – e.g. Ling et al (2009). Some of the correlation coefficients are significantly high (in absolute terms) and the situation is improved when only the later part of the sample period (1996-2012) is used for the computation (Panel B). Finally, the PS measure seems to have the highest average correlation coefficient, embedding information contained in several other liquidity measures.

Finally, these results generally hold (with some minor exceptions) when the different sectors are analysed separately. Tables A1, A2 and A3 in the Appendix report the correlation matrices of liquidity measures computed respectively for retail, office and industrial properties.

3. DATA DESCRIPTION AND MARKET LIQUIDITY MEASURES

Figure 3.1: Liquidity Measures by Sector



3. DATA DESCRIPTION AND MARKET LIQUIDITY MEASURES

Importantly, it is desirable to guarantee that these proxies show patterns in line with expectations. In particular, liquidity measures should be able to capture market cycles to reflect a signaling power, especially during phases of market distress such as the crisis at the end of the 1980s / beginning of 1990s and the most recent one starting at the beginning of 2007.

Figure 3.1 shows the cyclical pattern of all measures for the three different sectors. At first glance, the different measures behave according to predictions, signalling markets with liquidity pressure during periods of falling markets (i.e. spikes for illiquidity measures such as Amihud, Roll and Return/Turnover, and sharp declines for liquidity measures such as transaction volumes, turnover, net flows and PS measure). Transaction volumes, the Amihud measure and Return/Turnover suggest that industrial is the least liquid sector, with retail and office properties leading in the ranking at different points in time. Particularly over the last economic crisis, the illiquidity of office markets seemed to lag the one in retail markets.

The only notable issue is the flat representation of the Amihud measure after 1995. This is primarily due to the high values of this measure in the first part of the sample period. However, if only the time series from 1996 is plotted, a surge in illiquidity during the most recent crisis may be clearly observed.

Finally, as a cross-sector comparison, average measures and their volatilities are reported in Table 3.4. The dominance of a sector is not clear from the statistics and, hence, significant differences in liquidity levels between different sectors are not infered. Turnover suggests Offices to be the most liquid sector, with Retail in a very similar position if the Amihud measure is also considered. Generally, the ranking of the three sectors by volatilities is found to vary across measures and differences are not statistically significant in many cases.

Table 3.4: Average and Standard Deviation of Liquidity Measures
Panel A: Sample 1988-2012

	Volumes	Turnover	Net flows	Amihud	Roll	Ret/Turn	PS
Average							
All Property	183.7	2.0%	0.4%	0.4%	0.7%	1.9%	117.6
Retail	91.8	2.0%	0.4%	0.9%	0.7%	2.0%	50.6
Office	77.0	2.4%	0.3%	1.4%	0.7%	1.7%	41.1
Industrial	35.0	2.0%	0.5%	3.1%	0.7%	1.8%	21.8
Standard Deviation							
All Property	148.6	0.8%	0.8%	0.7%	0.8%	3.1%	205.3
Retail	74.9	0.9%	0.9%	1.4%	0.8%	3.3%	107.3
Office	62.9	1.0%	1.2%	2.3%	0.9%	2.5%	90.6
Industrial	26.7	0.9%	1.0%	6.7%	0.9%	2.5%	38.2

3. DATA DESCRIPTION AND MARKET LIQUIDITY MEASURES

Table 3.4 Continued
Panel B: Sample 1996-2012

	Volumes	Turnover	Net flows	Amihud	Roll	Ret/Turn	PS
Average							
All Property	241.2	1.9%	0.5%	0.1%	0.7%	2.0%	171.8
Retail	123.4	1.9%	0.5%	0.3%	0.7%	2.2%	73.4
Office	100.8	2.3%	0.4%	0.3%	0.8%	1.4%	60.9
Industrial	46.8	1.9%	0.6%	0.6%	0.7%	1.5%	31.7
Standard Deviation							
All Property	147.2	0.8%	0.8%	0.2%	1.0%	3.6%	225.2
Retail	70.7	0.8%	0.8%	0.4%	1.0%	3.8%	122.2
Office	62.7	0.9%	1.2%	0.4%	1.0%	2.7%	102.2
Industrial	24.5	0.7%	0.9%	0.6%	1.0%	2.1%	42.2

Overall, several liquidity measures have been computed that show a certain degree of similarity. These measures are clearly not to be used as measures per se because they only identify proxies. In fact, it is of paramount importance to embed these measures in a formal modelling exercise that permits the pricing of liquidity and, hence, estimation of the premium an investor might expect.

In Sections 2 and 3, theoretical models have been presented and the data used for the estimation. In the next section, three main models are applied and the main empirical results discussed. Firstly, the impact of TOM on the standard deviation of returns is reported. The liquidation bias is then computed, as a premium compensating investors for the inability to transact instantaneously. Finally, the premium associated with market liquidity is estimated, using the five-factor model and the different proxies for market liquidity.

4. EMPIRICAL RESULTS

In this Section, the results of the three main models are reported. The TOM bias leads to an increase of ex-ante risk perceived by investors and this worsens the return/risk profile of real estate investment. The liquidation bias reduces the return investors expect to achieve ex-ante because they may need to concede price discounts when they sell their assets. Finally, the liquidity in the overall market may lead investors to require a risk premium to invest in illiquid real estate assets.

TOM Bias

The increase in ex-ante risk estimates due to TOM is reported in Table 4.1. The average and standard deviation of returns for each property sector are computed using the IPD Annual Index. Some results are also included from an estimation using the two main indices for the residential sector: Nationwide and Halifax. The average TOM is taken from averages of the sell-side sample in Devaney and Scofield (2014) for the commercial real estate market and the beta coefficients for the volatility ratio are computed as in Cheng et al. (2013) – but with annual data – and reported in the last column of the last two panels of the table. The average TOM for residential markets has been taken from Rightmove for both house price indices.

Table 4.1: Changes in Volatilities Due to Time On Market
Panel A: Effect of TOM on Volatilities

				Holding Period t (years)				
	Average	St.Dev.	TOM (months)	5	8	10	12	15
All Property	9.45%	10.03%	5.2	10.2%	10.1%	10.1%	10.1%	10.1%
Retail	10.12%	9.56%	4.9	9.7%	9.7%	9.6%	9.6%	9.6%
Office	8.78%	11.34%	5.4	11.5%	11.4%	11.4%	11.4%	11.4%
Industrial	10.41%	10.65%	5.2	10.8%	10.8%	10.7%	10.7%	10.7%
Nationwide	6.63%	8.95%	2.7	9.0%	9.0%	9.0%	9.0%	9.0%
Halifax	6.26%	9.66%	2.7	9.7%	9.7%	9.7%	9.7%	9.7%

Panel B: Combined Effect of TOM and Non-randomness on Volatilities

				Holding Period t (years)					
	Average	St.Dev.	TOM (months)	5	8	10	12	15	βt
All Property	9.45%	10.03%	5.2	14.5%	17.1%	18.6%	20.1%	22.1%	0.53
Retail	10.12%	9.56%	4.9	14.3%	17.0%	18.6%	20.0%	22.0%	0.56
Office	8.78%	11.34%	5.4	17.6%	20.9%	22.9%	24.7%	27.3%	0.58
Industrial	10.41%	10.65%	5.2	18.5%	22.3%	24.5%	26.6%	29.4%	0.68
Nationwide	6.63%	8.95%	2.7	12.3%	14.6%	15.9%	17.1%	18.8%	0.51
Halifax	6.26%	9.66%	2.7	13.3%	15.7%	17.2%	18.5%	20.3%	0.51

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Table 4.1 continued
Panel C: Extra volatility exclusively due to TOM assuming non-randomness

	Average	St.Dev.	TOM (months)	Holding Period t (years)					
				5	8	10	12	15	βt
All Property	9.45%	10.03%	5.2	0.6%	0.4%	0.4%	0.3%	0.3%	0.53
Retail	10.12%	9.56%	4.9	0.5%	0.4%	0.4%	0.3%	0.3%	0.56
Office	8.78%	11.34%	5.4	0.7%	0.5%	0.5%	0.4%	0.4%	0.58
Industrial	10.41%	10.65%	5.2	0.8%	0.6%	0.5%	0.5%	0.4%	0.68
Nationwide	6.63%	8.95%	2.7	0.2%	0.2%	0.2%	0.1%	0.1%	0.51
Halifax	6.26%	9.66%	2.7	0.2%	0.2%	0.2%	0.2%	0.1%	0.51

Note: Commercial real estate returns are taken from IPD. Nationwide and Halifax represent the main residential indices used in the UK market. TOM is the sell-side time on market measured by Devaney and Scofield (2014). TOM for the residential market (for both indices) is taken from Rightmove.com.

Panel A shows that, assuming the randomness of real estate returns, the adjustment to their volatility due to TOM is negligible and decreases as the holding period (*t*) increases. However, when deviating from randomness (Panel B), volatilities are significantly different and they range between 12.3% (residential Nationwide for five-year holding period) and 29.4% (Industrial for 15-year holding period). The ranking of sectors by risk is maintained and sectors with a high risk (e.g. industrial) see a higher impact of TOM on volatilities. As the holding horizon increases, the volatility increases (in line with expectation about the riskiness of asset returns and maturities, as represented by an upward yield curve). However, the marginal extra volatility exclusively due to TOM (hence excluding the complementary effect of non-randomness) decreases as the holding period increases because the impact of the same length on TOM for longer horizons should decrease when measured periodically – annual returns are reported. Finally, the impact of TOM is significantly influenced by the deviation from the assumption of random real estate returns and this feature is dominant. In fact, the size of the impact reported in Panel C is bigger than the one obtained assuming randomness – i.e. subtracting the original standard deviation from the one reported in Panel A.

Liquidation Bias

The second bias identified in the modelling section is due to the difficulty of a sudden liquidation, i.e. the inability of investors to sell their assets at observed market prices immediately, as happens in financial markets. Table 4.2 reports the annual risk premium associated the liquidation bias in Panel A and the extra volatility (measured as adjusted minus original volatility) introduced by such bias in Panel B.

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Table 4.2: Liquidation Bias Estimates
Panel A: Risk Premium for Liquidation Bias

	Average	St.Dev.	TOM (months)	Holding Period t (years)				
				5	8	10	12	15
All Property	9.45%	10.03%	5.2	3.2%	2.6%	2.3%	2.1%	1.9%
Retail	10.12%	9.56%	4.9	2.9%	2.3%	2.1%	1.9%	1.7%
Office	8.78%	11.34%	5.4	3.8%	3.1%	2.8%	2.5%	2.3%
Industrial	10.41%	10.65%	5.2	3.4%	2.7%	2.5%	2.3%	2.0%
Nationwide	6.63%	8.95%	2.7	1.5%	1.2%	1.1%	1.0%	0.9%
Halifax	6.26%	9.66%	2.7	1.6%	1.3%	1.2%	1.1%	1.0%

Panel B: Extra Volatility for Liquidation Bias

	Average	St.Dev.	TOM (months)	Holding Period t (years)				
				5	8	10	12	15
All Property	9.45%	10.03%	5.2	3.2%	3.6%	3.7%	3.8%	3.9%
Retail	10.12%	9.56%	4.9	2.9%	3.2%	3.4%	3.5%	3.5%
Office	8.78%	11.34%	5.4	3.8%	4.3%	4.4%	4.5%	4.7%
Industrial	10.41%	10.65%	5.2	3.4%	3.8%	4.0%	4.1%	4.2%
Nationwide	6.63%	8.95%	2.7	1.5%	1.7%	1.8%	1.8%	1.8%
Halifax	6.26%	9.66%	2.7	1.6%	1.8%	1.9%	1.9%	2.0%

Note: Commercial real estate returns are taken from IPD. Nationwide and Halifax represent the main residential indices used in the UK market. TOM is the sell-side time on market measured by Devaney and Scofield (2014). TOM for the residential market (for both indices) is taken from Rightmove.com.

Firstly, the annual risk premium (Panel A) for an investor with short holding period (five years) is around 3.2% for commercial real estate (ranging from 2.9% for retail to 3.8% for offices) and around 1.5% for residential properties, which show a much lower time on market than the commercial segment. Secondly, this premium tends to decrease for longer investment horizons (15 years) to respectively 1.9% (ranging 1.7% - 2.3%) and 1.0%. Overall, it may be concluded that investors are expected to require an ex-ante premium due to liquidation bias, which ranges between 1.0% and 3.5% depending upon the investment horizon (and given the assumptions on marketing time).

Finally, as far as ex-ante risk measures are concerned (Panel B), the liquidation-adjusted ex-ante volatility seems to be around 30% to 40% (20% for residential properties) higher than the original one. This assumption leads to a perception of the risk/return profile of real estate investments, which is worse than the one computed with original data. Consequently, this adjusted profile may also help to explain the lower than predicted allocations to property given by institutional investors. If allocators use the new estimated values of volatility, the Sharpe ratio of real estate decreases and hence optimisation models should suggest a smaller percentage to be invested in this illiquid asset.

4. EMPIRICAL RESULTS

Market Liquidity Premium

The final step of this analysis aims to identify the premium linked to market liquidity. The Pastor and Stambaugh (2003) model is estimated using the different measures of liquidity computed in section 3. Table 4.3 shows the estimated coefficients and main statistics of the models using the full sample 1988-2012. Since some of the liquidity measures behave differently from the mid-1990s, the results using the sample 1996-2012 are also reported as a robustness check (see Table 4.4). Generally, it is found that market risk and the growth (HML) and size (SMB) factors are positive and significant. Furthermore, liquidity is important in explaining returns and this is consistent throughout all liquidity measures used (each column represents the estimation of the model using a different liquidity measure). As expected, proxies representing illiquidity rather than liquidity (i.e. Amihud, Roll and Return/Turnover) are found to show a negative sign. The overall *R*-squared varies across models, with models using Turnover, Net Flows, Return/Turnover and PS showing the best fit and information criteria. When the models are estimated by sector (Panels B to D), generally a confirmation of the main results are found at the All Property level, with some minor exceptions for the Industrial sector.

Table 4.3: Estimated model (full sample: 1988-2012)
Panel A: All Property

	Volumes	Turnover	Net Flows	Amihud	Roll	Ret/Turn	PS
C	-0.001	-0.008***	-0.002***	0.002***	0.003***	0.006***	-0.002***
RMRF	0.039**	0.037**	0.028**	0.042***	0.04**	0.03**	0.026**
SMB	0.059***	0.065***	0.063***	0.057***	0.056***	0.029	0.032**
HML	0.049**	0.043*	0.043**	0.046**	0.042*	0.013	0.019
UMD	0.028	0.026	0.016	0.027	0.025	0.008	0.015
LIQ	0.014***	0.476***	0.84***	-0.172*	-0.204***	-0.196***	0.035***
Adjusted *R*-squared	0.08	0.15	0.41	0.05	0.06	0.30	0.41
F-statistics	5.93	11.20	43.02	4.27	5.12	26.37	42.57
Akaike info criterion	-6.13	-6.21	-6.58	-6.10	-6.12	-6.40	-6.58
Schwarz criterion	-6.05	-6.13	-6.51	-6.03	-6.04	-6.33	-6.50
Hannan-Quinn criter.	-6.10	-6.18	-6.55	-6.07	-6.09	-6.37	-6.55

4. EMPIRICAL RESULTS

Table 4.3: Estimated model (full sample: 1988-2012) continued
Panel B: Retail

	Volumes	Turnover	Net Flows	Amihud	Roll	Ret/Turn	PS
C	-0.002*	-0.01***	-0.001**	0.002***	0.003***	0.006***	0.001
RMRF	0.045***	0.041***	0.034**	0.049***	0.046***	0.034**	0.041***
SMB	0.057***	0.058***	0.055***	0.054**	0.054**	0.021	0.046**
HML	0.05**	0.041*	0.031	0.043*	0.04*	0.018	0.031
UMD	0.033*	0.026	0.013	0.031*	0.029	0.021	0.027
LIQ	0.036***	0.592***	0.78***	-0.111**	-0.181**	-0.198***	0.034***
Adjusted *R*-squared	0.09	0.22	0.38	0.06	0.06	0.33	0.15
F-statistics	7.15	17.87	37.84	4.77	4.69	30.47	11.42
Akaike info criterion	-6.08	-6.23	-6.46	-6.04	-6.04	-6.38	-6.14
Schwarz criterion	-6.00	-6.15	-6.39	-5.97	-5.96	-6.31	-6.07
Hannan-Quinn criter.	-6.05	-6.20	-6.43	-6.01	-6.01	-6.35	-6.11

Panel C: Office

	Volumes	Turnover	Net Flows	Amihud	Roll	Ret/Turn	PS
C	-0.001	-0.009***	-0.001	0.003***	0.002**	0.006***	0.001**
RMRF	0.038**	0.03*	0.032**	0.042**	0.038**	0.025*	0.038**
SMB	0.066***	0.064***	0.069***	0.059***	0.064***	0.011	0.07***
HML	0.062**	0.067***	0.067***	0.051**	0.053**	0.019	0.055**
UMD	0.033*	0.029	0.03*	0.028	0.028	0.014	0.035*
LIQ	0.029***	0.44***	0.548***	-0.106***	-0.149*	-0.298***	0.047***
Adjusted *R*-squared	0.06	0.17	0.31	0.08	0.05	0.36	0.18
F-statistics	5.06	13.32	27.22	6.17	4.36	34.17	14.20
Akaike info criterion	-5.96	-6.08	-6.26	-5.98	-5.95	-6.34	-6.09
Schwarz criterion	-5.89	-6.01	-6.18	-5.90	-5.87	-6.26	-6.02
Hannan-Quinn criter.	-5.93	-6.05	-6.23	-5.95	-5.92	-6.31	-6.06

4. EMPIRICAL RESULTS

Table 4.3: Estimated model (full sample: 1988-2012) continued
Panel D: Industrial

	Volumes	Turnover	Net Flows	Amihud	Roll	Ret/Turn	PS
C	0.003***	-0.004**	0.000	0.002***	0.005***	0.006***	0.004***
RMRF	0.028*	0.024	0.021*	0.027*	0.027*	0.020	0.019
SMB	0.052***	0.057***	0.063***	0.055***	0.046**	0.036*	0.044**
HML	0.037	0.038*	0.027	0.037*	0.030	0.023	0.035*
UMD	0.017	0.020	0.010	0.017	0.013	0.009	0.014
LIQ	-0.010	0.358***	0.656***	0.033***	-0.282***	-0.127***	0.088***
Adjusted *R*-squared	0.03	0.11	0.36	0.07	0.07	0.10	0.15
F-statistics	2.62	8.00	33.98	5.28	5.74	7.96	11.36
Akaike info criterion	-6.19	-6.27	-6.60	-6.23	-6.24	-6.27	-6.32
Schwarz criterion	-6.12	-6.20	-6.53	-6.16	-6.17	-6.20	-6.25
Hannan-Quinn criter.	-6.16	-6.24	-6.57	-6.20	-6.21	-6.24	-6.29

Note: The LIQ coefficients for Volumes and PS measures have been multiplied by 1000 to make them comparable in size to coefficients estimated with other measures.

Table 4.4: Estimated model (sample: 1996-2012)
Panel A: All Property

	Volumes	Turnover	Net Flows	Amihud	Roll	Ret/Turn	PS
C	0.000	-0.007***	-0.001	0.007***	0.005***	0.008***	-0.003***
RMRF	0.059***	0.053***	0.04**	0.055***	0.062***	0.041***	0.038***
SMB	0.049**	0.048**	0.062***	0.021	0.039*	-0.002	0.021
HML	0.038	0.031	0.037*	-0.005	0.024	-0.018	0.006
UMD	0.025	0.020	0.013	-0.002	0.019	-0.005	0.010
LIQ	0.01*	0.504***	0.813***	-2.931***	-0.279***	-0.223***	0.034***
Adjusted *R*-squared	0.07	0.17	0.40	0.28	0.11	0.52	0.48
F-statistics	3.94	9.30	28.02	16.62	5.82	44.54	38.11
Akaike info criterion	-6.13	-6.25	-6.57	-6.39	-6.18	-6.79	-6.71
Schwarz criterion	-6.04	-6.15	-6.48	-6.29	-6.08	-6.69	-6.61
Hannan-Quinn criter.	-6.09	-6.21	-6.53	-6.35	-6.14	-6.75	-6.67

4. EMPIRICAL RESULTS

Table 4.4: Estimated model (sample: 1996-2012) continued
Panel B: Retail

	Volumes	Turnover	Net Flows	Amihud	Roll	Ret/Turn	PS
C	-0.001	-0.01***	-0.001	0.007***	0.004***	0.008***	0.002*
RMRF	0.064***	0.052***	0.042**	0.064***	0.069***	0.044***	0.06***
SMB	0.051**	0.05**	0.066***	0.028	0.039	-0.011	0.035
HML	0.042	0.037	0.035	0.010	0.025	-0.010	0.022
UMD	0.030	0.021	0.011	0.011	0.022	0.008	0.022
LIQ	0.03**	0.653***	0.838***	-1.29***	-0.253***	-0.227***	0.029***
Adjusted *R*-squared	0.08	0.23	0.35	0.19	0.09	0.50	0.15
F-statistics	4.44	13.22	22.59	10.70	4.85	42.05	8.34
Akaike info criterion	-5.98	-6.16	-6.32	-6.11	-5.98	-6.59	-6.06
Schwarz criterion	-5.88	-6.06	-6.22	-6.01	-5.89	-6.50	-5.96
Hannan-Quinn criter.	-5.94	-6.12	-6.28	-6.07	-5.95	-6.55	-6.02

Panel C: Office

	Volumes	Turnover	Net Flows	Amihud	Roll	Ret/Turn	PS
C	0.002	-0.008***	0.000	0.007***	0.004***	0.008***	0.003***
RMRF	0.057***	0.048**	0.047***	0.053***	0.059***	0.034**	0.057***
SMB	0.052**	0.042*	0.061***	0.022	0.044*	-0.021	0.056**
HML	0.043	0.051**	0.055**	0.015	0.032	-0.008	0.039*
UMD	0.027	0.023	0.026	0.009	0.021	0.005	0.03*
LIQ	0.007	0.433***	0.544***	-1.299***	-0.235***	-0.323***	0.042***
Adjusted *R*-squared	0.05	0.17	0.35	0.24	0.09	0.56	0.24
F-statistics	3.22	9.09	22.72	13.72	5.21	51.75	13.71
Akaike info criterion	-6.08	-6.21	-6.46	-6.30	-6.13	-6.84	-6.30
Schwarz criterion	-5.99	-6.12	-6.36	-6.21	-6.03	-6.74	-6.21
Hannan-Quinn criter.	-6.05	-6.17	-6.42	-6.26	-6.09	-6.80	-6.26

4. EMPIRICAL RESULTS

Table 4.4: Estimated model (sample: 1996-2012) continued
Panel D: Industrial

	Volumes	Turnover	Net Flows	Amihud	Roll	Ret/Turn	PS
C	0.005***	-0.003	0.000	0.007***	0.006***	0.009***	0.004***
RMRF	0.048***	0.043**	0.034**	0.047***	0.05***	0.031**	0.037**
SMB	0.041**	0.042**	0.044***	0.028	0.033*	-0.004	0.033*
HML	0.026	0.027	0.007	0.000	0.014	-0.022	0.025
UMD	0.015	0.014	0.000	-0.002	0.009	-0.014	0.012
LIQ	-0.034	0.314***	0.701***	-0.504***	-0.36***	-0.324***	0.076***
Adjusted *R*-squared	0.05	0.10	0.43	0.12	0.16	0.46	0.20
F-statistics	3.17	5.43	31.52	6.77	8.76	35.24	10.84
Akaike info criterion	-6.37	-6.42	-6.88	-6.45	-6.49	-6.93	-6.54
Schwarz criterion	-6.27	-6.32	-6.78	-6.35	-6.40	-6.83	-6.44
Hannan-Quinn criter.	-6.33	-6.38	-6.84	-6.41	-6.45	-6.89	-6.50

Note: The LIQ coefficients for Volumes and PS measures have been multiplied by 1000 to make them comparable in size to coefficients estimated with other measures.

Furthermore, the liquidity premia is computed by multiplying the estimated coefficients of market liquidity with the average value of the liquidity measure over the sample period used in the estimation procedure. The top part of Table 4.5 shows the annualised liquidity premia estimated for the full sample. Firstly, premia at the all-property level range from as little as 1% (with Amihud) to as much as 12% (with Turnover). If these results may initially seem inconclusive, they are consistent with studies of other asset classes if turnover is excluded that clearly suggests a far too high premium (above 10% on average). Moreover, if a simple average of all the premia is taken, a premium around 4.50% is obtained (or 3.26% if the estimation using turnover is excluded). When estimating models by sector, consistent results are generally found with the exception of PS (showing a slightly smaller premium at sector than at the all-property level) and Amihud (showing a higher premium at sector than at the all-property level). Since the different behaviour of some liquidity measures after the mid-1990s determines unexpected differences at sector level for some of the liquidity measures, results for estimations using the restricted sample (1996-2012) are also reported in the bottom part of the table. This set of results is found to be even more coherent, as the restricted sample gives a greater weight to the observations of the most recent crisis. Hence, that the estimated coefficients are also found to be generally higher than the ones obtained for the full sample (around 1.0%-1.5% difference).

Finally, if the difference between sectors are scrutinised, the Industrial sector may be expected to be the most illiquid market, with either Retail or Offices being the most liquid. However, the liquidity premium of the Retail sector is found to be the highest (either 4.94% or 6.43% for the two sample periods), followed by Offices (5.54% or 5.12%) and Industrial (3.50% or 4.84%). One possible explanation may be offered by the information theory. In fact, the Retail and Office sectors are much more competitive both nationally and internationally. Hence, the information set available in these markets is probably larger than the one in the Industrial sector. This availability allows investors to readily embed this information in their behaviour and, therefore, the pricing may be reflecting more readily the information attached to the investment flows of economic agents.

4. EMPIRICAL RESULTS

Table 4.5: Estimated Annual Liquidity Premia

	Volumes	Turnover	Net Flows	Amihud	Roll	Ret/Turn	PS	Average	Average (excl. Turnover)
Sample 1988-2012									
All Property	3.19%	11.95%	4.08%	0.88%	1.77%	4.61%	5.01%	**4.50%**	**3.26%**
Retail	4.06%	14.91%	3.67%	1.19%	1.57%	4.84%	4.36%	**4.94%**	**3.28%**
Office	2.74%	13.41%	2.09%	1.73%	1.34%	6.14%	4.33%	**4.54%**	**3.06%**
Industrial	0.42%	8.71%	4.19%	1.25%	2.54%	2.76%	4.61%	**3.50%**	**2.63%**
Sample 1996-2012									
All Property	2.86%	11.90%	4.91%	5.11%	2.37%	5.65%	7.15%	**5.71%**	**4.67%**
Retail	4.57%	16.14%	4.76%	5.12%	2.15%	6.12%	6.17%	**6.43%**	**4.81%**
Office	0.87%	12.83%	2.94%	5.40%	2.18%	5.74%	5.89%	**5.12%**	**3.83%**
Industrial	1.94%	7.52%	4.77%	3.58%	3.17%	5.82%	7.06%	**4.84%**	**4.39%**

So far, models have been estimated statically, using a long sample period. However, it is also desirable to show the time-varying nature of the models and to test their stability in predicting liquidity premia over time. Hence, the Pastor and Stambaugh (2003) model is estimated monthly, using a five-year rolling window (i.e. 60 observations). Along with average and standard deviation of estimated liquidity premia, Table 4.6 reports their values at three different points in time: before the crisis (December 2006), in the middle of the liquidity dry-out (December 2008) and at the end of the sample period (December 2012). Values are computed for All property and the three main sectors.

Table 4.6: Liquidity Premia Estimated with Rolling Windows (60 months)

	Volumes	Turnover	Net Flows	Amihud	Roll	Ret/Turn	PS	Average	Average (excl. Turnover)
All Property									
Average	11.27%	15.80%	3.03%	4.69%	4.45%	6.30%	3.87%	**7.06%**	**4.47%**
St.Dev.	9.68%	9.01%	2.33%	2.83%	4.01%	4.25%	2.45%	**4.94%**	**3.17%**
Dec 2006	5.08%	6.14%	2.85%	5.45%	4.50%	6.67%	5.08%	**5.11%**	**4.91%**
Dec 2008	28.83%	36.25%	10.13%	7.56%	13.37%	11.42%	8.79%	**16.62%**	**10.25%**
Dec 2012	2.62%	4.96%	0.56%	9.56%	0.09%	12.49%	3.21%	**4.78%**	**5.18%**
Retail									
Average	13.13%	14.77%	3.14%	5.26%	4.21%	6.59%	3.32%	**7.20%**	**4.50%**
St.Dev.	10.71%	9.94%	2.18%	3.01%	3.99%	4.31%	1.87%	**5.14%**	**3.07%**
Dec 2006	2.04%	2.60%	1.00%	5.05%	3.01%	5.02%	2.04%	**2.97%**	**3.23%**
Dec 2008	22.09%	20.72%	8.31%	9.48%	13.28%	12.36%	7.48%	**13.39%**	**10.18%**
Dec 2012	21.13%	24.92%	2.24%	9.26%	1.59%	11.81%	4.61%	**10.79%**	**5.90%**

4. EMPIRICAL RESULTS

Table 4.6: Liquidity Premia Estimated with Rolling Windows (60 months)

	Volumes	Turnover	Net Flows	Amihud	Roll	Ret/Turn	PS	Average	Average (excl. Turnover)
Office									
Average	10.17%	13.43%	2.46%	4.89%	4.98%	6.63%	3.62%	**6.60%**	**4.52%**
St.Dev.	6.60%	7.29%	2.08%	3.61%	4.87%	4.87%	1.81%	**4.45%**	**3.45%**
Dec 2006	8.91%	10.39%	3.79%	1.30%	3.03%	6.25%	6.51%	**5.74%**	**4.18%**
Dec 2008	11.92%	25.80%	9.32%	8.54%	14.94%	11.38%	6.63%	**12.65%**	**10.16%**
Dec 2012	5.11%	7.34%	2.84%	8.77%	0.06%	10.47%	3.90%	**5.50%**	**5.21%**
Industrial									
Average	3.95%	5.91%	2.42%	4.61%	4.13%	5.15%	3.08%	**4.18%**	**3.88%**
St.Dev.	3.00%	4.17%	2.10%	3.45%	3.12%	4.83%	2.16%	**3.26%**	**3.13%**
Dec 2006	2.58%	1.53%	2.46%	4.78%	1.61%	3.84%	2.58%	**2.77%**	**3.06%**
Dec 2008	2.41%	9.45%	9.46%	11.43%	11.75%	12.55%	7.51%	**9.22%**	**10.54%**
Dec 2012	7.63%	1.76%	2.00%	9.08%	2.50%	12.33%	4.00%	**5.61%**	**5.98%**

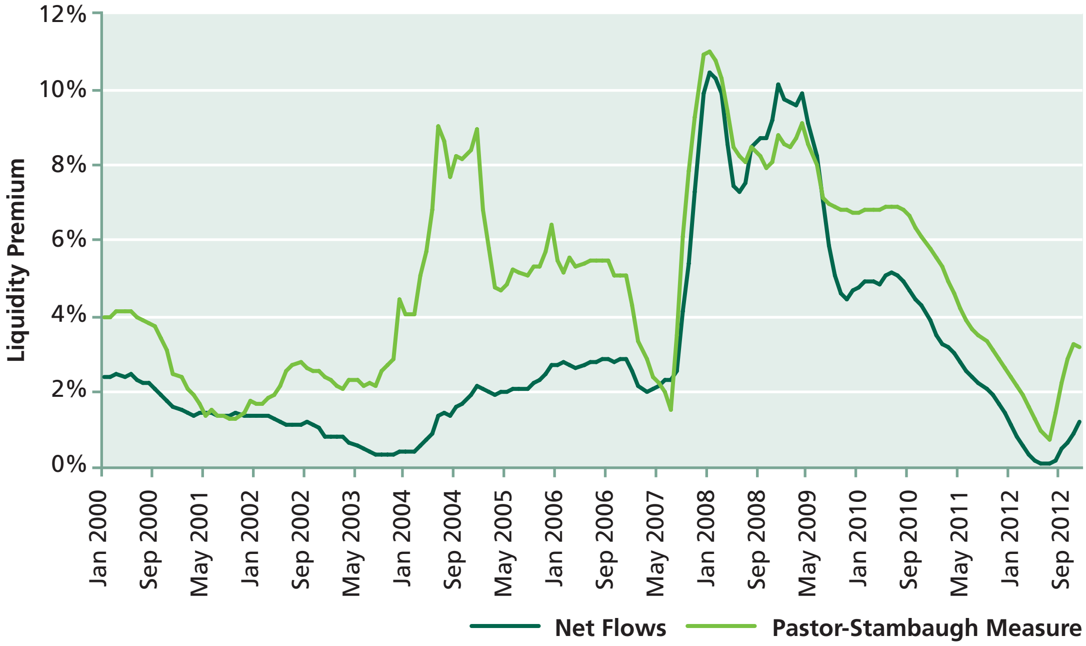
The overall average of liquidity premia is around 7% and confirms previous results obtained with a single estimation using the full sample (4.50%). In this rolling procedure, however, both volumes and turnover found show very high premia peaking at the end of 2008 to a level of 29% to 36% for all property. Since these values are clearly beyond reasonable expectation, overall averages excluding these coefficients are presented in the last column. In this case, the overall average premium for All Property is found to be around 4.5% (in line with the static estimation), with a maximum premium of 10.2% (compared to 16.6% including the two measures) during the most recent economic crisis. At the end of 2006, both averages (last figure of the last two columns) suggested a premium of around 5% for all property.

Comparing results between sectors overall market liquidity risk seems to be highest for Offices and Retail. This result is in line with the greater swings of liquidity in this sector than in others, which make this risk less predictable. However, during the recent economic crisis (December 2008), as in the previous estimation using the full sample, industrial recorded the highest liquidity risk premium.

Finally, among all liquidity proxies, results are mostly stable using net flows and the Pastor and Stambaugh (2003) measure, which suggest an overall premium of 3.0%-3.5% for All Property and between 2.5% and 3.5% for different sectors. Accordingly, in Figure 4.1 the graph of the liquidity premia computed with the two measures from 2000 onwards. Premia were initially stable at around 2% to 4%, to find a slight temporary increase (mainly recorded by the PS measure) when transactions were low around 2004-2006. Importantly, the liquidity premia computed with the two different measures seem to be much more aligned over the most recent period. Just before the economic downturn, liquidity became an important factor and premia suddenly increased to 10% (for both measures) by the end of 2007. Since the middle of 2009 they have started to decrease back to the initial levels of 2%-3%, suggesting a reduction in the pressure of liquidity on the pricing of real estate assets.

4. EMPIRICAL RESULTS

Figure 4.1: Liquidity Premium over Time



5. CONCLUSIONS

Overall, several models have been applied to understand the impact of liquidity on the ex-ante return and risk profile of an illiquid asset such as real estate. Time on market, coupled with non-random returns, can generate a perceived ex-ante risk that is 30% to 40% higher than the one observed in ex-post returns.

Using the argument of a possible liquidation bias – because investors cannot necessarily sell assets as and when they want – the impact of such stylised fact has also been computed and found to be even more significant than the TOM effect, with the impact on risk – mainly driven by the correction for serial correlation – almost double the one measured by ex-post measures and a liquidation premium varying between 2% and 3%.

Finally, the estimation of risk premia linked to market liquidity consistently showed the significance of this risk factor (with the exception of volumes in some models) throughout. Even if some of the estimated figures are clearly not in line with expectation (e.g. too high when transaction volumes and turnover are used), over time, premia are on average around 3.0%-3.5% and they range between 1.5% during rising markets (i.e. when it is easy to find a counterparty and transactions can happen very quickly) and 10% when a liquidity dry-out happens (e.g. during the most recent economic crisis). These estimates are also in line with the ones suggested for more traditional asset classes (bonds and equities) by Hibbert et al. (2009), which range between 0.1% (for very low risk bonds) and 3.5% to 5.5% (for either domestic or international equities).

Overall, considering both the liquidation bias approach and the market liquidity estimation, conclusive evidence is found that the ex-ante illiquidity premium is around 3% on average and it varies over time ranging from 1.5%-2.0% to 10%. At the same time, investors normally use a rough estimate of 2%-4% for the overall risk premium (including several factors such as obsolescence, tenant default and illiquidity) to determine the required rate of return for real estate assets. Clearly the ex-ante figure seems to overestimate the liquidity premium according to such view, highlighting once more the presence of a risk premium puzzle. If on one hand, investors may argue that ex-post returns do not justify a 3% liquidity premium, on the other hand, the cost associated with illiquidity (i.e. inability to sell or to sell within a short period of time) is not necessarily recorded in IPD return data. In fact, if a property is not sold due to the inability to find a counterparty, this information remains hidden because the transaction price (and, hence, discount due to liquidity) is not observed.

Moreover, the estimated liquidity premium does not necessarily imply a radical shift of required returns and consequent repricing of the asset class. As an illustrative example, assume that the long-run risk - free rate is around 3.0%-3.5%, obsolescence is estimated at 1.5% and the illiquidity premium is around 3.0%. Adopting the practitioner's view, a newly constructed building with a good quality tenant and located in London should require an ex-ante return of around 7.0%-7.5%, which is in line with the ex-ante return (including potential future growth) required by investors for these types of properties.

Finally, the author argues that these results are helpful for the real estate industry because some of the measures suggested and tested in this paper may be periodically updated and offered to the market, along with the estimation of premia using the simple models that have been illustrated.

APPENDIX A: CHENG ET AL. (2013) ESTIMATION PROCEDURE

The final equation used to obtain the ex-ante standard deviation from the Cheng et al. (2013) model is the following:

Equation A1

$$\sigma^2_{ex\text{-}ante} = (t + t_{TOM})(\beta^T)^2\sigma^2_t + 2\sigma^2_t\beta^T(1-\beta^T) + \frac{(ret^2 + (\beta^T)^2\sigma^2_t)\,\sigma^2_{TOM} + \sigma^2_t(1-\beta^T)^2}{t + t_{TOM}}$$

where β^T represents the extent to which returns are smoothed.

The estimation procedure suggested by Cheng et al. (2013) works as follows:

1. they compute time series of returns for different holding periods (from 1 to *n* quarters) and their standard deviations – the present study uses annual observations as the focus is on annualised return and risk;
2. they calculate the ratio between each standard deviation and the standard deviation of one-period returns (for period one, this ratio will be equal to one and it will increase as the holding period increases from 1 to *n*);
3. they run a regression using this ratio (minus 1) as dependent variable and the investment horizon (minus 1) as independent variable (with intercept equal to zero). The estimated coefficient is referred to as β^T.

Values of β^T have been estimated for the different sectors of the UK real estate market, which are directly reported in Section 5. The coefficient of the overall market using quarterly data is equal to 0.76, which is in line with the one computed by Cheng et al. (2013) for the US market (respectively 0.9 and 0.6-0.7 for commercial and residential markets).

For the main exercise, the focus is on annual risk and return, so the estimate using annual returns is utilised and this is equal to 0.53 for the overall property market. The fact that the number is smaller than for quarterly data reflects the less prominent need to correct the risk with annual data than with quarterly data (i.e. the issue of smoothing is more pronounced in the latter than in the former). Among sectors, Retail and Offices show estimates similar to the overall market while industrial reflects a lower degree of randomness than average.

As a final remark, it is worth noting that Equation (A1) shrinks back to Equation (2) if there is no deviation from randomness. Intuitively, it can simply be assumed that Equation (A1) is the same as Equation (2), where an adjustment to the volatility is made, an estimate from historical returns is as follows:

$$\sigma_{adj} = (\sigma_t + \beta^T(t-1)\,\sigma_t)$$

And Equation (A1) can be rewritten as

$$\sigma^2_{ex\text{-}ante} = (t + t_{TOM})\sigma_{adj} + ret^2 * \sigma^2_{TOM}$$

APPENDIX B: LIQUIDATION BIAS MODEL

Following the derivation of the formula for ex-ante return and volatility considering a liquidation bias – as in Lin and Vandell (2007) – the annualised return and risk measures are computed correcting for the impact of holding period and marketing time as follows[7]:

Equation B1

$$ret_{ex\text{-}ante} = ret - \sqrt{3} \ * E\,[\,t_{eMktg}\,] \ * \sigma_t$$

Equation B2

$$\sigma_{ex\text{-}ante} = (1 + \ t_{Mktg})\sigma_t$$

where t_{Mktg} represents the average marketing time.

Intuitively, both the ex-ante return and volatility depend on the expected marketing period and the ex-post standard deviation[8], where an increase in marketing time and/or ex-post standard deviation determines a rise in both the ex-ante volatility – equation (B2) – and the liquidation premium (reducing the ex-ante return – equation (B1) – and, hence, increasing the difference between ex-ante and ex-post returns).

[7] See Lin and Vandell (2007) for the derivation of equations.

[8] The multiplicative factor √3 comes from a mathematical derivation of the final equation. See Lin and Vandell (2007) for further explanation.

APPENDIX C: FURTHER TABLES

Table C1: Correlation Coefficients of Liquidity Measures for Retail Properties
Panel A: Retail 1988-2012

	Volumes	Turnover	Net Flows	Amihud	Roll	Ret/Turn	PS
Volumes	1.00	0.14	0.36	-0.42	0.20	0.11	0.57
Turnover		1.00	0.42	-0.03	0.00	-0.29	0.31
Net Flows			1.00	-0.12	-0.06	-0.19	0.57
Amihud				1.00	0.09	0.31	-0.24
Roll					1.00	0.47	-0.16
Ret/Turn							-0.30
PS							1.00

Panel B: Retail 1996-2012

	Volumes	Turnover	Net Flows	Amihud	Roll	Ret/Turn	PS
Volumes	1.00	0.25	0.43	-0.22	0.27	0.09	0.51
Turnover		1.00	0.54	-0.03	-0.14	-0.31	0.40
Net Flows			1.00	-0.17	-0.17	-0.27	0.67
Amihud				1.00	0.43	0.72	-0.32
Roll					1.00	0.53	-0.19
Ret/Turn						1.00	-0.37
PS							1.00

Table C2: Correlation Coefficients of Liquidity Measures for Office Properties
Panel A: Retail 1988-2012

	Volumes	Turnover	Net Flows	Amihud	Roll	Ret/Turn	PS
Volumes	1.00	0.27	0.22	-0.43	0.28	0.02	0.41
Turnover		1.00	0.21	-0.14	-0.05	-0.25	0.30
Net Flows			1.00	-0.10	-0.18	-0.15	0.57
Amihud				1.00	-0.05	0.45	-0.25
Roll					1.00	0.36	-0.23
Ret/Turn						1.00	-0.38
PS							1.00

APPENDIX C: FURTHER TABLES

Table C2: Correlation Coefficients of Liquidity Measures for Retail Properties continued
Panel B: Retail 1996-2012

	Volumes	Turnover	Net Flows	Amihud	Roll	Ret/Turn	PS
Volumes	1.00	0.42	0.20	-0.21	0.32	0.16	0.30
Turnover		1.00	0.45	-0.10	-0.13	-0.20	0.39
Net Flows			1.00	-0.15	-0.33	-0.20	0.66
Amihud				1.00	0.38	0.71	-0.39
Roll					1.00	0.48	-0.27
Ret/Turn						1.00	-0.40
PS							1.00

Table C3: Correlation Coefficients of Liquidity Measures for Industrial Properties
Panel A: Retail 1988-2012

	Volumes	Turnover	Net Flows	Amihud	Roll	Ret/Turn	PS
Volumes	1.00	0.22	0.18	-0.41	0.24	-0.02	0.46
Turnover		1.00	0.55	-0.06	-0.05	-0.26	0.26
Net Flows			1.00	-0.04	-0.29	-0.25	0.60
Amihud				1.00	0.02	0.49	-0.23
Roll					1.00	0.39	-0.35
Ret/Turn						1.00	-0.45
PS							1.00

Panel B: Retail 1996-2012

	Volumes	Turnover	Net Flows	Amihud	Roll	Ret/Turn	PS
Volumes	1.00	0.38	0.22	-0.13	0.36	0.24	0.31
Turnover		1.00	0.58	-0.02	-0.13	-0.21	0.38
Net Flows			1.00	-0.31	-0.43	-0.44	0.75
Amihud				1.00	0.40	0.64	-0.50
Roll					1.00	0.61	-0.40
Ret/Turn						1.00	-0.59
PS							1.00

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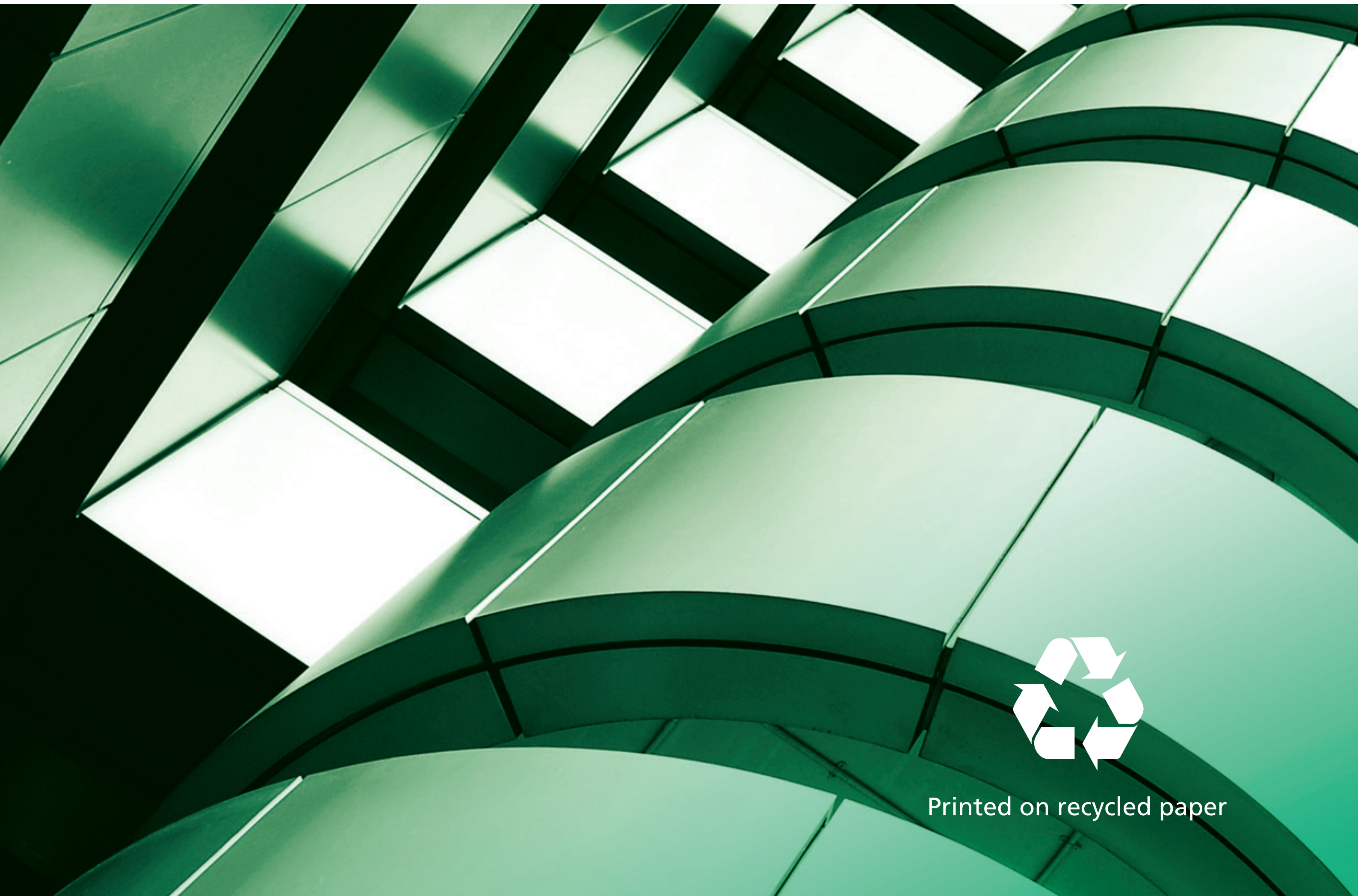

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