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Is There a Term Structure? Empirical Evidence from Shanghai Office Rental Market

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This paper mainly conducts an empirical study of the term structure of the Shanghai office rental market. Based on 555 executed contracts in the Shanghai office rental market from 2005 to 2008, the building quality and micro location are controlled, which are generally omitted in previous studies, through ranking of buildings and dividing the sample into 11 small central business districts (CBDs). The empirical results show that there is a downward term structure in the Shanghai market, but it is not very consistent during the studied years.

Keywords

Term structure; Lease, Shanghai; Office rental

1. Introduction

As the financial centre of China, Shanghai is experiencing high-speed growth in the office rental market. Although numerous papers in real estate finance have discussed the factors that determine lease rates, there is no conclusive result yet. Among the different research interests in determining lease rates, the question of whether there is a term structure in rent that is similar to that in interest rates is not yet fully explored. Grenadier (1995) constructs endogenous processes for rent, supply, and asset values by using fundamental economic uncertainty and competitiveness between individual and value-maximizing firms. The conclusion is that for a market in which the supply has recently increased, there is a downward-sloping term structure for lease rates. On the contrary, there is an upward-sloping term structure for a market experiencing a severe economic depression. Slade (2000) uses the rental data of office properties in the Phoenix metropolitan area to investigate the office rental determinants during market decline and recovery, and finds that the economic cycle indeed greatly affects the rental rates. In the paper, Slade focuses on the rental area which has a similar pattern as that of the lease term. Buetow & Albert (1998) show that renewal options in real estate leases have a significant value and demonstrate ways to estimate the value of embedded options in lease contracts. Along this line, Grenadier (2001) extends the perfect competition model of the term structure to an oligopolistic property market model and also provides valuation formulas for many common leasing arrangements, such as forward leases, leases with cancellation or renewal options and indexed leases. Gunnelin and Söderberg (2003) first estimate the different term structures of lease rates in the Stockholm CBD office rental market from 1977-1991. Using 15 years of data, term structure is estimated by year and finally, they identify 15 consecutive term structures. In the 15 years, 7 years of data show a significant term structure. As well, the estimated term structure can predict future rental levels to a certain degree. Moreover, the studied period includes a pronounced boom and bust phase, which is used to evaluate the term structure in different stages of the property cycle.

Englund, Gunnelin and Söderberg (2002) consider a very special lease; an upward-only adjusting lease, which is very common in the United Kingdom (UK). They derive a model which takes into account the expected growth and volatility of asset service flow, and come to the conclusion that the upward-only lease will have a substantial effect on the initial rent.

Clapham and Gunnelin (2003) extend the term structure model by deriving an equilibrium relationship in a general continuous time setting in which the short rentals and interest rates are stochastic. Similar to the expectation hypothesis of interest rates, the objective expectation about future rentals can mislead the interpretation of the term structure. The effect of risk aversion and interest rate uncertainty on equilibrium should be taken into consideration. Simulations are done to show that different combinations of risk aversion and interest rates can lead to quite different patterns of the term structure, which means that there are more than three types of patterns as described by Grenadier (1995).

Englund et al. (2004) use 4000 office rental agreements in the three largest cities of Sweden to investigate the importance of lease terms on rent determination. They show that the indices can be substantially distorted if the term of lease is not taken into consideration. Furthermore, since the term structure is determined by expectations on future spot rentals, it should be taken into consideration whether the forward rentals implicit in the term structure are good estimators of the future spot rentals. However, they show that the forward rents have only relatively weak power in prediction.

Along the same line, Bond, Loizou and McAllister (2008) has completed empirical research on commercial property in the UK to investigate the term structure. In their paper, they focus on the lease length and initial lease rates in the London office market from 1994 to 2004. In their regression model, size, location, quality of building, year of origination, timing of lease breaks, and lease term are taken into consideration. They find that the term structure of the initial lease rates is upward sloping and this trend does not change over time. This result is quite robust even when they controlled the micro-location and tenant credit rating as well as potential endogeneity. This result is not consistent with Grenadier (2001), but with the findings by Clapham and Gunnelin (2003).

In this paper, the primary focus is on the term structure in the Shanghai office rental market. This is the first paper that studies the term structure of the office rental market in China, which will act as a source for international comparison and provide a better understanding of the theoretical model. The remainder of this paper is as follows. Section 1 will provide a discussion of our dataset, and how we choose and use the variables. Section 2 presents the empirical models and details the differences between them. Section 3 gives the empirical results and interpretation. Finally, the conclusion is in Section 4.

2. Data

The dataset consists of the final executed 555 Grade A office leases in Shanghai from 2005 to 2008. Here, Grade A office is defined as within the CBD, modern with high quality finishing, flexible layout, large floor plates, spacious, well decorated lobbies and circulation areas, effective central air-conditioning, good lift services zoned for passengers and goods deliveries, professional management, and parking facilities. These offices are located in all of the CBDs in Shanghai, so it is representative for the entire Shanghai office market. One of the possible limitations of this dataset is that most of the leases run for 2-3 years, some for 1 year and a few for 5 years. However, the issue is not the incompleteness of data collection, but the characteristics of office building leases in China.[1] According to Hines (2000), the typical length of lease in Asia generally runs from 1 to 3 years, 5 to 10 years in North America, and for European, Middle Eastern, and African leases, somewhere in between. Office leases in England, Scotland, and Wales are generally 5, 10, or 15 years. It can also be seen from Bond, Loizou and McAllister (2008) that the dataset used in their paper, the UK Commercial Property Leases, is typically a 10, 15 or 20 year lease. The potential problem is that, due to lack of observations in other maturity leases, conclusions about the term structure should be made carefully, especially when 80-90% of the sample are typical leases.

The uniform grade of the office provides a simple way to control the building quality. However, since there is no official definition of Grade A office buildings and even if two buildings are both Grade A, there are differences in quality. In order to control the effects of building quality on rent, we divided all the buildings into 4 groups, from rank 1 to rank 4[2], in which 1 is the best quality and 4 represents the worst quality.

Although all of these buildings are in 1 of the 7 CBDs in Shanghai, there are some differences among the CBDs which may affect the rent. The location of the property was grouped according to the CBD areas, but not the official districts. To control the location factor, each district was treated as a dummy variable as well as with respect to the interactive terms of location and building quality. There are 11 groups of the office-cluster areas, by which we can control the effects of location and guarantee that in the same area, buildings that are equally ranked have nearly the same rent. This is very important because in our dataset, there are some samples located in a high-tech park where the rent is much lower than that in the CBD even if both buildings are ranked 1.

A significant change in the dataset occurs in 2008 when the rent was based on the Renminbi (RMB) instead of US dollars as in prior contracts. Since most of the Grade A office lessees were international companies, the US dollar-based rent was convenient for them. However, in 2008, the RMB exchange rate against US dollar greatly appreciated over the past two years (about 15%) and the lessors wanted to reduce their losses and exchange rate risks, so they changed the rent and based it on the RMB. For us, this created a problem in deciding whether all of the US dollar-based rentals should be converted into RMB or vice versa. We chose the latter, because to convert data, the exact date of the signed contract was required, but we only had data from 2008.

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[1] The most frequent lease term in Gunnelin and Söderberg's dataset is 1 to 3 years. However, it is 10 to 15 years in Bond, Loizou and McAllister's data set. This shows the different characteristics of each nation's office property market.

[2] Actually, we did not do this ranking job by ourselves. Here, we would like to thank Zhang Dong, a professional trader in the Shanghai office rental market, for his immense help in ranking all of the buildings. As well, to avoid unnecessary confusion, we did not divide the ranking into too many groups.

No option clause is considered in this paper for two reasons: one, it is very rare (about 10 cases in all) that there is an option; two, the option can have a significant value, which may affect the final analysis result. Since the lease term (1-6 years and most of them are 2 and 3 years) in Shanghai is relatively shorter than that of the UK (which is 10 and 15 years), then the options in the contract, such as a break out option or upward only rent is not that important because the lessee and lessor would have the opportunity to adjust their contract within a short period of time.

2.1 Variables and descriptive statistics

We collected the following variables from the contracts. The variables are described in Table 1.

Instead of using the consumer price index (CPI) as the price deflator, the rent is deflated by the real estate price index of the office rental market which is more reliable in capturing the price changes. This index data is found on the website of the Shanghai Municipal Statistics Bureau.[3]

Table 1 Description of the Data Set

Variables	Definition
district	The location of the property
arealeased	Leased area in the contract
year	Year that the contract was signed
Rentfee	Rental fee in the contract. It is not a necessary part of the contract and mostly seen in the rank 1 properties
rank	The rank of the property quality, 1 represents the highest quality and 4 represents the lowest quality
leaseterm	The lease term in the executed contract
leaseterm2	Square of lease term
lnarea	Log of the leased area
lnrent	Log of the rental contract, the rent is measured by USD per square meter per month
xyear_2006 ~ xyear_2008	The dummy variable of the year
xyeaXlea_2006 ~ xyeaXlea_2008	The dummy variable of the interaction term between lease term and year
qyeaXlea_2006	The dummy variable of the interaction term between leaseterm2 and year
_Idistrict_2 ~ _Idistrict_11	The dummy variables of the district
_Irank_2 ~ -Irank_4	The dummy variable of the rank, rank 1 is the omitted group
_IdisXran_2_2 ~ _IdisXran_11_4	The dummy variable of the interaction term between rank and district

[3] The website is http://www.statssh.gov.cn/2003shtj/tjnj/nje07.htm?d1=2007tjnje/e0812.htm

The rental fee in contracts is collected to control differences in the standard contract. In our dataset, it is rare that a contract would have a rental fee and those with rental fees are rank 1 office contracts. The rental fee was used as a variable to control the building quality. Actually, we can show in the following regression that the rental fee variable just slightly affects the model. Details will be discussed later.

Below, Table 2 shows the distribution of leases by lease length and year. As we discussed in the data section, the lease term in China is generally 2-3 years and few are above 4 year maturity, in contrast to the 10-20 years in the UK, and 1-3 years in Sweden. We can see from Table 2 that the patterns for lease length stay the same.

Table 2 Lease Term Distribution of Contracts from 2005 to 2008

Year/lease term	1	1.5	2	2.5	3	4	5	6	Total
2005	3		22		24				49
2006	8		93	2	150	1	1	2	257
2007	1	1	46		96		3		147
2008	3		36		61		2		102
Total	15	1	197	2	331	1	6	2	555

Note: The term is measured by year and the numbers in the table are the number of observations in the total sample.

Table 3 shows the descriptive statistics of the lease contracts in the sample. The total sample is grouped by districts and year. The following variables are reported in the table: average rent, standard deviation of rent, average lease term, standard deviation of the lease term, average lease area, standard deviation of the lease area, average rental fee and standard deviation of rental fee. The rent in this table has been deflated by the real estate price index. The "count" variable is the number of leases. The blank in the table is because there is no observation for that year or district. We can see from the table that the rent in 2008 is much higher than that for other years, from about 22 in 2005-2007 to 34 in 2008.

2.2 Empirical model

In this paper, the log of the rent is the explained variable and lease term, log of the lease area, interaction term of rank and district, and dummy variable of the year are the explanatory variables. This regression model is mainly based on Gunnelin and Söderberg (2003)'s model. The model is as follows:

$$\ln(rent) = \beta_0 + \beta_1 \ln(leasearea) + \beta_2 leaseterm + \beta_3 leaseterm2 + \sum_{i=1}^{11} \theta_i * \_\text{Idistrict}\_i$$
$$+ \sum_{j=2006}^{2008} \gamma_i * \text{xyear}\_j + \sum_{k=2}^{4} \eta_k * \_\text{Irank}\_k + \sum_{j,k} \lambda_l * \_\text{Irank}\_j\_k + u \tag{1}$$

Table 3 The Descriptive Statistics of the Data Set

Year	Data	District 1	District 2	District 3	District 4	District 5	District 6	District 7	District 8	District 9	District 10	District 11	Grand Total
2005	Ave of rent	16.97	29.67		19.97	29.94			29.73	19.50	16.99		22.19
	Sd of rent	1.32	8.51		6.58	4.33			8.55	0.00	0.88		7.88
	Ave of leaseterm	2.63	2.60		2.57	2.50			2.83	1.00	2.14		2.43
	Sd of leaseterm	0.52	0.52		0.53	0.71			0.41	0.00	0.53		0.61
	Ave of area	466.05	1266.50		1074.69	338.50			1330.24	116.70	152.99		713.26
	Sd of area	561.54	1352.36		892.19	147.79			1491.30	0.00	247.47		994.95
	Ave of rent fee1.06	1.30		1.57	0.50			0.50	0.00	1.29		1.11	
	Sd of rent fee	1.15	1.25		1.62	0.71			0.84	0.00	1.07		1.17
	Count	8.00	10.00		7.00	2.00			6.00	2.00	14.00		49.00
2006	Ave of rent	14.99	27.25	14.88	25.70	25.90	20.19	16.98	21.92	20.91	15.51	16.80	21.41
	Sd of rent	5.43	9.15	6.79	6.64	11.55	3.03	3.79	8.24	10.37	4.12	10.03	9.37
	Ave of leaseterm	2.88	2.67	3.00	2.57	2.55	2.40	2.20	2.74	2.38	2.52	2.67	2.61
	Sd of leaseterm	0.33	0.48	0.00	0.51	0.53	0.89	0.52	0.50	0.77	1.21	0.65	0.65
	Ave of area	1670.21	851.18	3481.90	938.22	1416.76	749.46	840.95	938.54	765.25	766.66	862.55	1114.04
	Sd of area	1758.53	893.98	2141.67	1038.00	1701.17	749.21	722.66	838.02	946.17	1418.19	745.37	1348.68
	Ave of rent fee	1.17	1.00	1.71	0.41	2.15	0.90	1.58	1.41	0.92	1.33	1.13	1.34
	Sd of rent fee	1.36	1.33	1.11	0.69	2.54	0.89	1.39	1.31	1.19	1.14	1.09	1.60
	Count	26.00	36.00	7.00	23.00	47.00	5.00	20.00	39.00	13.00	29.00	12.00	257.00
2007	Ave of rent	16.64	31.60	22.81	28.99	24.47	22.25	17.75	23.34	28.69		24.91	23.04
	Sd of rent	4.34	8.70	3.64	5.69	11.48	0.24	6.95	6.19	8.37		4.39	8.60
	Ave of leaseterm	2.92	2.70	2.33	2.64	2.84	2.00	2.51	2.81	2.83		2.80	2.70
	Sd of leaseterm	0.29	0.84	0.58	0.50	0.69	0.00	0.69	0.40	0.41		0.45	0.59
	Ave of area	1697.12	1300.40	697.98	1433.18	1024.80	900.00	1180.24	1045.23	1653.50		1560.04	1218.13
	Sd of area	1373.66	1032.37	444.57	1390.44	1075.14	141.42	1755.87	735.55	1003.39		512.87	1229.64
	Ave of rent fee2.50	1.70	0.33	1.46	1.37	2.00	2.22	1.68	1.33		1.88	1.80	
	Sd of rent fee 1.51	1.91	0.58	1.04	1.57	0.00	1.43	1.27	1.03		0.55	1.42	
	Count	12.00	15.00	3.00	11.00	19.00	2.00	37.00	37.00	6.00		5.00	147.00
2008	Ave of rent	20.20	37.02	24.09	40.59	42.67	23.90	25.16	33.36	21.12		27.14	34.13
	Sd of rent	5.42	11.46	4.88	8.96	16.46		6.46	7.10	2.31		4.72	11.60
	Ave of leaseterm	1.33	2.67	2.25	2.70	2.73	2.00	3.00	2.70	1.50		2.73	2.63
	Sd of leaseterm	0.58	0.49	0.46	0.47	0.47		0.77	0.48	0.71		0.90	0.64
	Ave of area	766.67	814.56	469.81	1532.43	1385.73	2300.00	1947.28	612.20	1200.00		1531.35	1281.70
	Sd of area	202.07	606.37	269.34	1275.39	1452.91		1716.73	537.63	141.42		1440.69	1229.25
	Ave of rent fee0.33	0.83	0.75	0.94	0.91	0.00	0.91	0.20	0.00		1.27	0.82	
	Sd of rent fee	0.58	0.81	0.53	1.03	1.04		0.83	0.42	0.00		1.27	0.94
	Count	3.00	12.00	8.00	33.00	11.00	1.00	11.00	10.00	2.00		11.00	102.00
	Total Count	49	73	18	74	79	8	68	92	23	43	28	555

where *ln(rent)* is the log of the deflated contract rent; *leasearea* is the log of the lease area; *leaseterm* is the contract lease maturity; *leaseterm2* is the square of the lease term; *_Idistrict* is the dummy variable of the location; *xyear* is the dummy variable of year; *_Irank_k* is the dummy variable of the building rank; *_Irank_j_k* is the dummy variable of the interaction term of rank and districts.

This equation is used to verify whether there is a hump in the term structure. We have merged all the data from the different years and estimated the equation while keeping the year dummy to control the difference between the years. We have also estimated the equation year by year to see whether there is a different term structure in different years.

An alternative equation is not to include the quadratic form of the lease term. The reason is that the lease term in our data set is discrete and only gets 1-6 years so the quadratic form may not fit well even if it is statistically significant.

$$\ln(rent) = \beta_0 + \beta_1 \ln(leasearea) + \beta_2 leaseterm + \sum_{i=1}^{11} \theta_i * \_\text{Idistrict}\_i + \sum_{j=2006}^{2008} \gamma_i * \text{xyear}\_j + \sum_{k=2}^{4} \eta_k * \_\text{Irank}\_k + \sum_{j,k} \lambda_l * \_\text{Irank}\_j\_k + u \quad (2)$$

The empirical result of using equations (1.1) and (1.2) are shown in Tables 4 and 5.

Table 4 The Regression Model 1: Regression ln(rent) Using Equation (1)

	Model 1 (year=2005)	Model 1 (year=2006)	Model 1 (year=2007)	Model 1 (year=2008)	Model 1 (total)
Dependent variable	Coef.	Coef.	Coef.	Coef.	Coef.
leaseterm	-0.13(0.733)	0.685(0.045)**	1.022(0)**	-0.07(0.657)	0.629(0)**
leaseterm2	0.009(0.909)	-0.15(0.005)**	-0.21(0)**	0.016(0.57)	-0.13(0)**
ln(area)	0.026(0.389)	-0.16(0.009)**	-0.03(0.239)	-0.05(0.007)**	-0.09(0.001)*
_IdisXra~1_4					
_IdisXra~1_3				-0.28(0.314)	-0.78(0.259)
_IdisXra~1_2		-0.94(0.101)			-0.45(0.627)
_IdisXra~0_4	-0.56(0.017)**	0.213(0.63)			0.231(0.285)
_IdisXra~0_3					
_IdisXra~0_2					
_IdisXra~9_4	-0.55(0.07)*	0.793(0.431)	-0.61(0.26)		-0.22(0.74)
_IdisXra~9_3			-0.19(0.736)		
_IdisXra~9_2					
_IdisXra~8_4		0.331(0.568)		0.513(0.112)	
_IdisXra~8_3			-0.11(0.611)		-0.24(0.378)
_IdisXra~8_2	-0.30(0.282)	0.052(0.931)	0.253(0.454)	0.306(0.318)	0.434(0.545)
_IdisXra~7_4		0.469(0.444)	-0.83(0.021)**		-0.60(0.41)
_IdisXra~7_3			-0.89(0.025)**		-1.01(0.146)
_IdisXra~7_2					
_IdisXra~6_4		0.328(0.711)			
_IdisXra~6_3			0.241(0.295)	-0.05(0.825)	-0.40(0.457)
_IdisXra~6_2					

(Continue …)

Table 4 Continued

	Model 1 (year=2005)	Model 1 (year=2006)	Model 1 (year=2007)	Model 1 (year=2008)	Model 1 (total)
Dependent variable	Coef.	Coef.	Coef.	Coef.	Coef.
_IdisXra~5_4		-0.39(0.674)	-0.87(0.047)**	-0.46(0.111)	-1.07(0.114)
_IdisXra~5_3	0.510(0.137)	-0.30(0.761)	-0.68(0.162)	-0.43(0.214)	-1.01(0.12)
_IdisXra~5_2		-0.08(0.938)			
_IdisXra~4_4	-0.18(0.433)		-0.59(0.275)		-0.76(0.297)
_IdisXra~4_3	0.365(0.161)		-0.58(0.257)	0.057(0.872)	-0.82(0.205)
_IdisXra~4_2		-0.54(0.65)	0.008(0.985)	0.139(0.531)	-0.35(0.282)
_IdisXra~3_4			-0.17(0.662)		
_IdisXra~3_3		-1.09(0.276)		-0.36(0.224)	-0.54(0.178)
_IdisXra~3_2					
_IdisXra~2_4		-0.25(0.79)	-0.67(0.23)	0.074(0.83)	-0.91(0.193)
_IdisXra~2_3		-0.36(0.745)	-0.64(0.228)	-0.44(0.261)	-1.15(0.083)
_IdisXra~2_2	0.168(0.397)	-0.69(0.543)	0.242(0.53)	-0.03(0.911)	-0.38(0.21)
_Irank_4	-0.50(0.008)**	-0.54(0.536)	0.221(0.616)	-0.77(0.002)**	0.261(0.692)
_Irank_3	-1.06(0)**	-0.20(0.833)	0.301(0.527)	-0.28(0.398)	0.556(0.372)
_Irank_2	-0.44(0.004)**	0.237(0.826)	-0.01(0.955)	-0.38(0.05)**	0.096(0.681)
_Idistric~11			0.670(0.036)	0.183(0.403)	0.795(0.205)
_Idistric~10					
_Idistrict_9		-0.34(0.724)	0.867(0.076)*	0.257(0.165)	0.643(0.291)
_Idistrict_8		-0.02(0.937)	0.373(0.03)**	0.057(0.776)	0.386(0.086)
_Idistrict_7		-0.14(0.706)	0.815(0.02)**	0.338(0.066)*	0.828(0.234)
_Idistrict_6		0.296(0.572)			0.629(0.175)
_Idistrict_5	-0.00(0.977)	0.328(0.733)	0.976(0.032)**	0.442(0.124)	1.128(0.078)
_Idistrict_4	-0.54(0.024)**	0.418(0.649)	0.937(0.052)*	0.152(0.6)	1.111(0.082)
_Idistrict_3		0.884(0.335)	0.428(0.163)	0.217(0.361)	0.376(0.284)
_Idistrict_2	-0.24(0.2)	0.688(0.488)	1.022(0.046)**	0.516(0.142)	1.401(0.032)
xyear_2006					-0.12(0.196)
xyear_2007					0.170(0.124)
xyear_2008					0.458(0)**
_cons	4.023(0)**	3.278(0.004)**	1.602(0.006)**	4.023(0)**	2.208(0.001)**
Prob > F	0	0	0	0	0
R-squared	0.8679	0.2603	0.6382	0.7879	0.3438
Adj R-squared	0.7954	0.1622	0.5447	0.7144	0.2981

The results above demonstrate that the term structure is a hump in 2006, 2007 and the merged total sample, while no term structure can be identified in 2005 and 2008. The positive sign on the lease term and negative sign on the square lease illustrate that occupiers pay a higher initial rent for a longer term if the lease maturity is less than 3 years, and a lower rent for a longer term if the term is more than 3 years. The highest rent has a maturity of 2, 2.5, and 3 years respectively in 2006, 2007 and the total sample. This coincides with the most frequently seen contracts in the rental market. A possible reason is that the office rental market in Shanghai is a seller's market because a report from DTZ shows that there has been an upward trend in the Shanghai office rental market from 2005. Actually, we can see from the year dummy that the rent increases significantly in 2008 and significant at the 1% level, while in 2006 and 2007, there are no considerable changes.

The coefficient of the lease area is not significant in all of the years. It has an expected negative sign in 2006, 2008 and the total sample, but not in 2005 and 2007. The coefficients of the dummy variables are also inconsistent in all of the samples. There are some significant variables, such as ranks and districts in 2005, 2007 and 2008, but none of them stands significant in 2006 and the total sample. However, although the variables are all insignificant, we cannot disregard them because they are jointly significant at the 1% level. (P-value=0, F value= 4.28)

Table 5 The Regression Model 2: Regression on ln(rent) Using Equation (2)

	Model 2 (year=2005)	Model 2 (year=2006)	Model 2 (year=2007)	Model 2 (year=2008)	Model 2 (total)
Dependent variable	Coef.	Coef.	Coef.	Coef.	Coef.
leaseterm	-0.09(0.13)	-0.22(0.037)**	-0.22(0) **	0.019(0.605)	-0.16(0.001) **
ln(area)	0.027(0.373)	-0.15(0.013) **	-0.04(0.145)	-0.05(0.007) **	-0.09(0.001) **
_IdisXra~1_4					
_IdisXra~1_3				-0.27(0.341)	-0.86(0.225)
_IdisXra~1_2		-1.06(0.069)			-0.55(0.558)
_IdisXra~0_4	-0.56(0.015) **	-0.01(0.969)			0.145(0.508)
_IdisXra~0_3					
_IdisXra~0_2					
_IdisXra~9_4	-0.53(0.051) *	0.636(0.533)	-0.69(0.262)	0.233(0.194)	-0.43(0.528)
_IdisXra~9_3			-0.30(0.645)		
_IdisXra~9_2					
_IdisXra~8_4		0.296(0.615)		0.454(0.135)	
_IdisXra~8_3			-0.19(0.465)		-0.31(0.27)
_IdisXra~8_2	0.211(0.378)	0.034(0.955)	0.273(0.481)	0.257(0.379)	0.433(0.554)
_IdisXra~7_4		0.431(0.488)	-1.11(0.007) **		-0.66(0.371)
_IdisXra~7_3			-1.11(0.014) **		-1.11(0.119)
_IdisXra~7_2					
_IdisXra~6_4		0.316(0.725)			
_IdisXra~6_3			0.060(0.816)	-0.05(0.824)	-0.43(0.434)
_IdisXra~6_2					
_IdisXra~5_4		-0.39(0.68)	-0.88(0.099) *	-0.47(0.101)	-1.07(0.122)
_IdisXra~5_3		-0.19(0.848)	-0.65(0.27)	-0.38(0.254)	-1.04(0.116)
_IdisXra~5_2		-0.06(0.955)	0.102(0.836)		
_IdisXra~4_4	-0.18(0.424)		-0.82(0.163)		-0.77(0.297)
_IdisXra~4_3	0.366(0.152)	-0.09(0.925)	-0.74(0.183)	0.097(0.78)	-0.89(0.181)
_IdisXra~4_2	0.514(0.125)	-0.52(0.67)		0.134(0.544)	-0.33(0.311)
_IdisXra~3_4			-0.05(0.907)		
_IdisXra~3_3		-1.09(0.284)		-0.32(0.265)	-0.60(0.142)
_IdisXra~3_2					
_IdisXra~2_4		-0.18(0.849)	-0.67(0.294)	0.063(0.854)	-0.87(0.221)
_IdisXra~2_3		-0.22(0.844)	-0.47(0.433)	-0.39(0.299)	-1.13(0.093) *
_IdisXra~2_2	0.685(0.028) **	-0.57(0.617)	0.269(0.539)	-0.02(0.928)	-0.34(0.275)

(Continue …)

Table 5 Continued

Dependent variable	Model 2 (year=2005) Coef.	Model 2 (year=2006) Coef.	Model 2 (year=2007) Coef.	Model 2 (year=2008) Coef.	Model 2 (total) Coef.
_Irank_4	-0.50(0.007) **	-0.66(0.452)	0.335(0.506)	-0.76(0.002)	0.217(0.746)
_Irank_3	-1.06(0) **	-0.33(0.73)	0.460(0.398)	-0.31(0.328)	0.584(0.358)
_Irank_2	-0.96(0.003) **	0.167(0.878)	0.059(0.866)	-0.38(0.049) **	0.081(0.734)
_Idistric~11			0.712(0.051) *	0.151(0.472)	0.886(0.166)
_Idistric~10					
_Idistrict_9		-0.51(0.61)	0.985(0.077) *		0.661(0.287)
_Idistrict_8	0.357(0.001) **	-0.06(0.852)	0.395(0.048)	0.053(0.79)	0.438(0.056) *
_Idistrict_7		-0.26(0.504)	0.902(0.035) **	0.286(0.07) **	0.872(0.22)
_Idistrict_6		0.170(0.748)			0.584(0.217)
_Idistrict_5	0.503(0.003) **	0.175(0.858)	0.943(0.087) *	0.389(0.15)	1.14(0.08) **
_Idistrict_4	-0.54(0.021) **	0.275(0.767)	1.034(0.046) **	0.105(0.705)	1.13(0.081) *
_Idistrict_3		0.891(0.338)	0.251(0.471)	0.169(0.443)	0.423(0.237)
_Idistrict_2	-0.24(0.184)	0.521(0.604)	0.861(0.138)	0.463(0.169)	1.38(0.037) **
xyear_2006					-0.14(0.16)
xyear_2007					0.158(0.162)
xyear_2008					0.429(0) **
_cons	3.973(0) **	4.708(0) **	3.361(0) **	3.932(0) **	3.292(0) **
Prob > F	0	0.0002	0	0	0
R-squared	0.8678	0.2341	0.5214	0.787	0.3157
Adj R-squared	0.8017	0.1362	0.4028	0.717	0.2696

ln(rent) is the log of the deflated contract rent; *leasearea* is the log of the contract lease area; *leaseterm* is the contract lease maturity; *leaseterm2* is the square of the lease term; *_Idistrict* is the dummy variable of the location; *xyear* is the dummy variable of the year; *_Irank_k* is the dummy variable of the building rank; *_Irank_j_k* is the dummy variable of the interaction term of rank and districts. The value in the bracket is the P-value. The value denoted by ** is significant at the 5% level, and the value denoted by * is significant at the 10% level.

The rental fee is not included in this regression model although we have this data, because we have verified that the "rentfee" variable only slightly numerically changes the coefficient, but does not affect the sign of the coefficient while reducing the adjusted R2.

Without the quadratic form of the lease term, the results in Table 5 are similar to that of using equation (1). The reason is that the linear can be a good approximating function if the value is limited to a small interval. In our case, nearly 80% of our sample has a maturity of 2-3 years and the range of the lease term is 6, so it is not that plausible to assume that it has a quadratic form. Even if it really has a quadratic form, we can say that the linear model is suitable given our dataset, at least to some extent.

ln(*rent*) is the log of the deflated contract rent; *leasearea* is the log of the contract lease area; *leaseterm* is the contract lease maturity; leaseterm2 is the square of the lease term; *_Idistrict* is the dummy variable of the location; *xyear* is the dummy variable of the year; *_Irank_k* is the dummy variable of the building rank; *_Irank_j_k* is the dummy variable of the interaction term of rank and districts. The value in the bracket is the P-value. The value denoted by ** is significant at the 5% level, and the value denoted by * is significant at the 10% level.

The results in Table 5 show that the term structure has a downward slope in 2006, 2007 and the merged total sample, while no term structure can be identified in 2005 and 2008. In other words, if there is a pattern using the quadratic form, it would still have a pattern in the linear form, and vice versa. The negative sign on the lease term suggests that lessees pay a higher initial rent for a shorter term. It is contrary to the findings of Gunnelin and Söderberg (2003), and Bond, Loizou and McAllister (2008), in which both of them show an upward term structure in the UK and Sweden office rental markets.

The coefficient of the lease area is not significant in some years. It has an expected negative sign in year 2006, 2008 and the total sample, but not in 2005 and 2007. The coefficients of the dummy variables are also inconsistent in all of the samples. Again, although the variables are all insignificant, we cannot disregard them because they are jointly significant at the 1% level. (P-value=0, F value= 5.29)

Another model that should be considered, controls an interaction term between lease term and year.

$$\ln(rent) = \beta_0 + \beta_1 \ln(leasearea) + \beta_2 leaseterm + \beta_3 leaseterm2 + \sum_{i=1}^{11} \theta_i * \_\text{Idistrict}\_i + \sum_{j=2006}^{2008} \gamma_i * \text{xyear}\_j + \sum_{k=2}^{4} \eta_k * \_\text{Irank}\_k + \sum_n \omega_n * \text{xyeaXle} + \sum_m \rho_m * \text{qyeaXle} + \sum_{j,k} \lambda_l * \_\text{Irank}\_j\_k + u \quad (3)$$

and

$$\ln(rent) = \beta_0 + \beta_1 \ln(leasearea) + \beta_2 leaseterm + \beta_3 leaseterm2 + \sum_{i=1}^{11} \theta_i * \_\text{Idistrict}\_i + \sum_{j=2006}^{2008} \gamma_i * \text{xyear}\_j + \sum_{k=2}^{4} \eta_k * \_\text{Irank}\_k + \sum_n \omega_n * \text{xyeaXle} + \sum_{j,k} \lambda_l * \_\text{Irank}\_j\_k + u \quad (4)$$

where the *xyeaXlea* is the dummy variable of the interaction term between the lease term and year, and *qyeaXlea* is the dummy variable of the interaction term between *leaseterm2* and year.

Table 6 contains the regression results using equations 3 and 4. With the interaction term, we allow the different years to have different term structures in one function. We can see that the coefficient of ln (*area*) is negative as expected. For model 3 that uses equation 3, the coefficient of the *leaseterm*, *leaseterm2* and all of the interaction terms are insignificant, but they are jointly significant in all of the variables that contain the lease term. (F=8.6, p-value=0) Hence, there is some pattern underlying the data, but with this specification, we cannot determine the exact form.

Based on the same rationale in equation 2, we run model 4 using equation 4. The coefficient of the lease term is small and insignificant at the 10% level. At the same time, the coefficient of the interaction term between lease term and year are all insignificant, except for 2006. Therefore, we can only identify that there is a term structure in 2006 and no statistical support for other years with respect to term structure. Most of the interaction terms between ranks and districts are insignificant, but again, they are jointly significant. Also, the term structure pattern is downwards.

Table 6 The Regression Models 3 & 4: Regression ln(rent) with Lease term*year

	Model 3 (using equation 3)	Model 4 (using equation 4)
Dependent variable	Coef.	Coef.
Lnarea	-0.06(0.024)* *	-0.08(0.002) **
Leaseterm	-0.15(0.887)	0.027(0.859)
leaseterm2	0.058(0.803)	
xyear_2006	0.375(0.355)	0.625(0.126)
xyear_2007	0.430(0.347)	0.686(0.137)
xyear_2008	0.158(0.729)	0.295(0.525)
xyeaXle~2006	-0.20(0.21)	-0.30(0.056) *
xyeaXle~2007	-0.10(0.547)	-0.21(0.228)
xyeaXle~2008	0.106(0.547)	0.038(0.831)
qyeaXle~2006	-0.02(0.907)	
qyeaXle~2007	-0.29(0.226)	
qyeaXle~2008	-0.21(0.362)	
_IdisXra~1_4		
_IdisXra~1_3	-0.78(0.26)	-0.84(0.229)
_IdisXra~1_2	-0.40(0.662)	-0.49(0.599)
_IdisXra~0_4	0.172(0.427)	0.092(0.673)
_IdisXra~0_3		
_IdisXra~0_2		
_IdisXra~9_4	-0.23(0.73)	-0.40(0.55)
_IdisXra~9_3		
_IdisXra~9_2		
_IdisXra~8_4		
_IdisXra~8_3	-0.18(0.509)	-0.24(0.388)
_IdisXra~8_2	0.494(0.489)	0.501(0.491)

(Continue …)

Table 6 Continued

	Model 3 (using equation 3)	Model 4 (using equation 4)
Dependent variable	Coef.	Coef.
_IdisXra~7_4	-0.68(0.35)	-0.75(0.309)
_IdisXra~7_3	-1.00(0.149)	-1.10(0.119)
_IdisXra~7_2		
_IdisXra~6_4		
_IdisXra~6_3	-0.40(0.447)	-0.44(0.42)
_IdisXra~6_2		
_IdisXra~5_4	-1.13(0.094)	-1.15(0.095) *
_IdisXra~5_3	-0.97(0.132)	-1.01(0.125)
_IdisXra~5_2		
_IdisXra~4_4	-0.82(0.256)	-0.86(0.245)
_IdisXra~4_3	-0.84(0.196)	-0.90(0.17)
_IdisXra~4_2	-0.37(0.248)	-0.37(0.265)
_IdisXra~3_4		
_IdisXra~3_3	-0.48(0.228)	-0.52(0.195)
_IdisXra~3_2		
_IdisXra~2_4	-0.98(0.161)	-0.96(0.176)
_IdisXra~2_3	-1.14(0.085)	-1.12(0.093)
_IdisXra~2_2	-0.37(0.225)	-0.34(0.272)
_Irank_4	0.298(0.649)	0.268(0.688)
_Irank_3	0.544(0.381)	0.572(0.365)
_Irank_2	0.086(0.711)	0.074(0.754)
_Idistric~11	0.729(0.244)	0.807(0.204)
_Idistric~10		
_Idistrict_9	0.618(0.308)	0.637(0.302)
_Idistrict_8	0.314(0.164)	0.353(0.123)
_Idistrict_7	0.791(0.254)	0.830(0.239)
_Idistrict_6	0.602(0.193)	0.558(0.235)
_Idistrict_5	1.095(0.086) *	1.112(0.086) *
_Idistrict_4	1.082(0.089) *	1.109(0.087) *
_Idistrict_3	0.350(0.316)	0.388(0.275)
_Idistrict_2	1.377(0.034) **	1.367(0.039)
_cons	2.016(0.008) **	2.800(0) **
Prob > F	0	0
R-squared	0.3782	0.3297
Adj R-squared	0.3259	0.2803

ln(*rent*) is the log of the deflated contract rent; *leasearea* is the log of the contract lease area; *leaseterm* is the contract lease maturity; *leaseterm2* is the square of the lease term; *_Idistrict* is the dummy variable of the location; *xyear* is the dummy variable of the year; *_Irank_k* is the dummy variable of the building rank; *_Irank_j_k* is the dummy variable of the interaction term of ranks and districts. *xyeaXlea* is the dummy variable of the interaction term between the lease term and year, and *qyeaXlea* is the dummy variable of the interaction term between *leaseterm2* and year. The value in the bracket is the P-value. The value denoted by ** is significant at the 5% level, and the value denoted by * is significant at the 10% level.

3. Conclusion

Since there is no previous research on the Shanghai office rental market, our study provides an international comparison and verifies the theory of the term structure. Based on 555 executed rental contracts of Shanghai Grade A office buildings, we have estimated the term structure of the Shanghai market from 2005 to 2008. With complete information of the contracts, we can control the micro location and building quality, which are usually omitted in previous studies, in order to obtain a better estimation. Linear and quadratic forms of the lease term in the regression model are discussed, and both results are provided. A downward term structure of the Shanghai market in 2006 and 2007 is found, but there is no pattern in 2005 and 2008. Constrained by the characteristics of the Shanghai office rental market where the lease term is typically 2-3 years and some are 4-6 years, the term structure estimation is more volatile as a consequence of the short term leases. More research in this area, such as international comparisons, will be of great help in understanding the underlying assumptions of existing term structure theory.

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References

Ambrose, B., Hendershott, P., & Klosek, M. (2002).Pricing Upward-only Adjusting Leases. *Journal of Real Estate Finance and Economics*, **25**, 1, 33–49.

Booth, P., & Walsh, D. (2001).An Option Pricing Approach to Valuing Upward Only Rent Review Properties With Multiple Reviews. *Insurance: Mathematics and Economics*, **28**, 2.

Booth, P., & Walsh, D. (2001).The Application of Financial Theory to the Pricing of Upward-only Rent Reviews. *Journal of Property Research,* **18**, 1, 69–83.

Bond, S, P Loizou, and P McAllister.(2008) Lease Maturity and Initial Rent: Is There a Term Structure for UK Commercial Property Leases? *Journal of Real Estate Finance & Economics*, May, **36**, 4.

Buetow, G., and Albert, J. (1998).The Pricing of Embedded Options in Real Estate Lease Contract. *Journal of Real Estate Research*, **15**, 3.

Clapham, E., and A Gunnelin.(2003). Rental Expectation and the Term Structure of Lease Rates. *Real Estate Economics*, **31,** 4.

Englund, P, Gunnelin, A., Hoesli, M. and Söderberg, B.(2004). Implicit Forward Rents as Predictors of Future Rents. *Real Estate Economics*, **32,** 2.

Grenadier, SR.(1995). Valuing Lease Contracts a Real-options Approach. *Journal of Financial Economics,* **38**, 3.

— 2001. An Equilibrium Analysis of Real Estate Leases B2 - An Equilibrium Analysis of Real Estate Leases, Graduate School of Business, Stanford University.

Gunnelin, Å., and Söderberg, B.(2003).Term Structures in the Office Rental Market in Stockholm. *Journal of Real Estate Finance & Economic*, **26**, 2/3.

Hines, MA. (2000). Investing in International Real Estate. Greenwood Publishing Group.

Slade, B. (2000) Office Rent Determinants During Market Decline and Recovery. *Journal of Real Estate Research*, **20**, 3.

Stanton, W., and Wallace, N. (2004). An Empirical Test of a Contingent Claims Lease Valuation Model. Working Paper, Haas School of Business U.C. Berkeley.

Wheaton, W. C. (2000).Percentage Rent in Retail Leasing: the Alignment of Landlord –Tenant interests. *Real Estate Economics*, **28**, 185–204.