Assessing the Value of Flexibility in the Dutch Office Sector using Real Option Analysis

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***Abstract*—Flexibility is one of the key aspects of the Zuidas project, a major construction project for office and housing space in the Amsterdam region. Real option analysis was used to estimate the value created by two specific kinds of flexibility: the option to postpone the construction of office space after certain preparations have been made, and the option to turn housing space into office space after a certain time.**

I. INTRODUCTION

INVESTMENTS in office space are notorious for their volatility. Office rents in an area can change considerably over a few years time, while there is a substantial lag time between planning and finishing new office space. Hence, the office market is notorious for being cyclic. Supply and demand are never in a stable equilibrium and rents exhibit large fluctuations [2]-[4].

These fluctuations are generally a threat to the financial viability of project development. The larger the future uncertainty, the larger the return on investment that an investor requires. Hence, it could be valuable to be able to shorten the lag time so as to escape from this cycle. Alternatively, it could be valuable to be able to turn housing space into office space (and back) according to the market situation. Whereas uncertainty is a threat to inflexible projects, it could even add value to projects that are flexible and can be adjusted to market developments.

The ‘Zuidas’, a large real estate project that is presently being established to the South of Amsterdam, aims to offer such flexibility. Central to the philosophy of the planners is the urge to be able to adapt the timing and purpose of buildings as market conditions require. The project allows for the construction of about 1,17 million square meters of office space, 1,09 million square meters of housing space and reserves about 0,49 square meters of hospital, shops et cetera [5].

In order to ensure the quality and financial viability of the project, various kinds of flexibility have been introduced. Decisions what to build first, and where, are based on market demand. In addition, the buildings themselves are constructed in such a way that they can be converted from office space into housing space and vice versa at relatively low costs.

These kinds of flexibility are considered an important and valuable aspect of the project [6]. This paper assesses the value that such flexibility adds and the optimal timing of the related decisions, using real option theory. For this purpose, the trend and volatility of developments in the Dutch office and housing sectors, as well as the covariance between developments in the two segments have been estimated. Section II discusses these estimations and the parameters that were used in the real option analysis in this paper. Section III discusses the valuation of the option to postpone the construction of office space after certain preparations have been made. Section IV discusses the valuation of the option to turn housing space into office space after a certain time. Section V concludes.

II. ESTIMATING MARKET PARAMETERS

A. *Offices*

The market for office space is notorious for its volatility. Demand and supply, and hence office rents react with different lag times to economic development, as a consequence of which the market never reaches a stable equilibrium [2]. According to an English study, supply lags demand by about three years [3]. The short-term price elasticity of demand is also found to be low, as demand is primary determined by macro-economic developments [4].

The combination of these two factors results in large volatility of office rents, whereas the duration of the cycle as well as the stage the market is within a cycle, often differ substantially between regions, and even within cities [4], [7].

A complicating factor when studying the drivers of office rents is the frequent use of so-called incentives. In bad times, suppliers prefer to offer rent holidays, complimentary square meters or furnishing, instead of lowering rents. This implies that the volatility of published rents will generally be an underestimation of the underlying developments in terms of turnover and return on investment. Considering these problems for deterministic office rent models, this paper chooses a different approach, viz. to analyze office rents as a Brownian motion.

Using various sources, a dataset with published office rents for over 30 major European business centers was constructed. Figure 1 shows the relative developments between 1995 and 2005 in this dataset.

Manuscript received 15 April, 2008. This work was based in the research report ‘*Opties op de Zuidas*’ [1], commissioned by the City of Amsterdam, The Netherlands

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Fig. 1 Office rent developments in European business centers 1995-2005

Subsequently, the year-to-year developments have been studied as a Brownian motion, consisting of a yearly random relative step that follows a normal distribution with a drift parameter. Table 1 shows the results of this analysis. The average developments can be modeled as a Brownian motion with an average year growth of 3,9% and a yearly volatility of 12,0%. Hence, yearly fluctuations are more than three times as large as the yearly trend. Office rent developments in four Dutch cities in the dataset show an average growth that is close to the European average, whereas volatility in Dutch cities has been smaller. Recall that these values will be an underestimation of the underlying developments, as a result of incentives.

Table 1 Brownian motion parameters of European office rents

	Average annual growth	**Annual volatility**
Europe		
Average	**3,9 %**	**12,0 %**
Maximum	10,9 % (London City)	24,6 % (La Défense)
Minimum	–0,8 % (Berlijn)	4,0 % (Düsseldorf)
Standard deviation	3,1 %	5,3 %
Amsterdam	4,5 %	7,7 %
Den Haag	3,9 %	7,4 %
Rotterdam	4,1 %	4,9 %
Utrecht	3,4 %	4,8 %

Subsequently, a dataset of average office rents in the 50 largest Dutch municipalities was studied. This dataset was obtained from Stichting Atlas voor Gemeenten. These data exhibit an average annual growth of 4,4%, varying from 1,4% to 9,4%.

B. *Housing*

Housing prices are much less volatile than office rents and price developments can to a large extend be explained by regional an macroeconomic variables [8]. Surprisingly, the effect of building costs on housing prices in the Netherlands is weak, even in models explaining long term developments [9]. This can be explained by the restrictive land use policy. Research for urban regions in the United States also indicates that the relation between construction costs and house prices has disappeared in the 1990s [10]. As a result, national house price developments will generally underestimate the regional volatility.

Figure 2 shows the relative development of housing prices (per square meter) in the 50 largest Dutch cities between 1996 and 2005. It can be seen that housing prices have been subject to much smaller volatility than office rents.

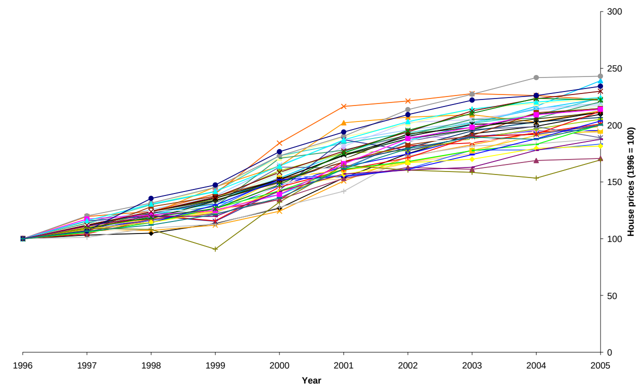

Fig. 2 Housing prices developments in the 50 largest Dutch municipalities 1995-2005

Like office rents, housing prices were analyzed using a Brownian motion model. Table 2 gives the parameters that were found. Surprisingly, developments in the four largest Dutch cities have been quite opposite to the national trend, experiencing larger volatilities for housing prices than for office rents.

Table 2 Brownian motion parameters of Dutch housing prices

	Average annual growth	**Annual volatility**
Average	**8,4 %**	**6,0 %**
Maximum	10,4 % (Haarlem)	17,5 % (Heerlen)
Minimum	6,0 % (Heerlen)	3,3 % (Leeuwarden)
Standard deviation	0,9 %	2,3 %
Amsterdam	8,9 %	10,0 %
Den Haag	7,7 %	11,1 %
Rotterdam	7,6 %	6,0 %
Utrecht	9,0 %	5,5 %

Note that the average annual *nominal* growth of 8,4% is unsustainable in the long run. It appears that a decade is too short a time span to assess the long term growth of housing prices. A more realistic figure can be obtained from the OECD, which studies housing prices in OECD countries between 1971 and 2002. This study found an average *real* growth of 2,9% for the Netherlands, and an average annual growth of 1,6% for all OECD countries combined. OECD estimates the real standard deviation of housing price developments in the Netherlands at 7,2% [11].

C. Correlation

Literature studying both the housing market and the office market is scarce, even though supply substitution seems possible for the construction sector [12]. However, the correlation coefficient between developments in housing and office space is a crucial input for assessing the value of switching between these functions.

The only study available [12] found a rather large correlation of 0,68 (0,64~071), while the variance of housing prices relative to that of office rents was found to be 0,21 (0,18~0,25), implying a relative volatility of 0,46 (0,42~0,50).

Figure 3 shows a scatter diagram with on the horizontal axis the relative growth of office rents and on the vertical axis the relative growth of housing prices in the 50 largest Dutch cities. The correlation coefficient for multi-year growth turns out to be only 0,13, which is much smaller than the value found for the United States in [12].

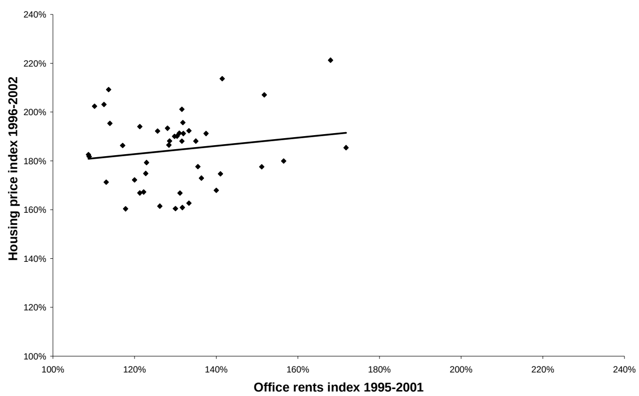

Fig. 3 Housing prices developments relative to development in office rents in the 50 largest Dutch municipalities 1995-2001/1996-2002

D. Parameters used in real option analysis

To model the average annual growth of office rents, a bandwidth between 2~6% was assumed (symmetric around the value of 4% that was found for European business centers). The volatility that was found (12%) was argued to be an underestimation; hence the value of 12 ± 5% has been raised to 15 ± 5%.

The average annual (nominal) growth assumed for housing prices is also 4%, which is substantially below the Dutch growth in the 1990s but rather in line with OECD estimations over a longer period. For the volatility of housing prices a bandwidth between 6~10% was assumed. This is slightly higher than the average value found for 50 Dutch cities in Table 2, but in line with the values found for the 4 largest cities in the Netherlands. Also, it is largely in line with the estimation for the Dutch market by the OECD.

Finally, for the correlation coefficient, an interval was assumed between the value found in the literature and the values estimated in this paper for the Dutch market. It seems likely that the Dutch correlation coefficient is smaller than that found in the literature, as a result of restrictive land use policy, which separates office and housing markets to a large extent.

Table 3 Parameters used in real option analysis

	Offices	**Houses**
Average annual growth	4 % (2 ~ 6 %)	4 % (3 ~ 5 %)
Standard deviation	15 % (10 ~ 20 %)	8 % (6 ~ 10 %)
Correlation coefficient	0,13 ~ 0,68	

III. Option to postpone

A. Parameters and model

An option represents the right, but not the obligation to make an investment and derives its value from the possibility *not* to exercise this right in the light of new information.

In order to assess the value of the option to postpone investing in office space, assumptions have been made about the costs and benefits of postponing.

Costs:
- Costs are related to owning land without using it.
- Postponing leads to a loss of revenues from rents.

Benefits:
- Postponing construction leads to lower (discounted) construction costs.
- Postponing allows for new information about market developments to be taken into account.

The true option value lies in the last bullet: if market developments are positive, the option will be exercised. If developments are less favorable, it will not be exercised.

This option value has been estimated using a standard Black-Sholes valuation model [13]. In this model, the value of an option (c) is:

$$c = S_0 c_1 - K e^{-rT} c_2$$

In this equation is:
- S_0 the value of the underlying asset at the moment of valuation. This is the net present value of all future rents.
- K the exercise price of the option. This is the investment required to construct the office building.

- c_1 and c_2 are exceeding probabilities, which are in turn determined by the average annual growth and volatility of office rents.
- *T* the duration of the option or the time the investment decision is postponed. This can be any positive number. Note that there is an additional time lag of about two years between the start and completion of the construction works.

B. *Results*

Using the parameters estimated and discussed in the former section (Table 3), the real option value is evaluated for various discrete waiting times *T* (Table 4), for an office building that consists of 16.000 square meters of office space (32 floors of 500 square meters), using the specific rent forecasts and construction costs assumed for Zuidas-offices. It was assumed that rents are fixed for 10 years at the prevailing market rate as soon as the building is let.

Table 4 Net value (option value minus costs) of postponing construction by *T* years, for different growth rates and volatilities of rents (million euro)

***T* = 1**				***T* = 3**		
Rent volatility	10%	15%	20%	10%	15%	20%
Nominal average growth rate						
2%	0.5	1.2	1.9	-1.3	-0.3	0.7
4%	1.0	1.4	2.0	-0.4	0.5	1.5
6%	1.4	2.0	2.7	2.3	2.8	3.6
***T* = 2**				***T* = 4**		
Rent volatility	10%	15%	20%	10%	15%	20%
Nominal average growth rate						
2%	0.1	0.9	1.8	-2.6	-1.6	-0.5
4%	0.2	1.0	1.9	-1.1	-0.2	0.8
6%	1.8	2.3	3.0	2.5	3.1	3.9

Assuming the average growth rate of office rents will not be larger than 4%, optimal postponement is 1 year. More delay leads to rent losses that exceed the value of higher rents after the office space is let. As can be expected, larger volatilities increase the value of waiting to invest. However, within the parameter ranges that were modeled, the optimal waiting time is one year for any volatility.

Higher average annual growth rates make it attractive to wait longer (this is a direct consequence from the assumption that rents are fixed at the prevailing market rate.

IV. Switch option

A. *Parameters and model*

Subsequently, the value of the option to switch between office and residential use of a building is assessed. In order to make this possible, the height of stories is crucial. For offices a story-height of 3,30 or even 3,60 m is required, while for residential use a height of 2,70 m is sufficient.

Buildings at the Zuidas project have a maximum overall height of 105 meters, dictated by regulations that result from the proximity of Schiphol. Thus, the number of floors an office building can sell or let is 32 compared to 39 for a residential building. Consequently, a flexible residential building can consist of 32 instead of 39 floors (18% less).

This implies a substantial drop in revenues, even if the revenue per square meter is assumed to be 5% or 10% higher as resident value a higher ceiling (‘high ceiling markup’).

Construction costs, on the other hand, will be less sensitive to the number of floors, as they depend largely on the costs of land, building foundations and the height of a building. Assuming 75% of total costs can be attributed to land, foundation and height, a flexible residential building with higher stories costs about 4,5% less, while revenues are reduced by a larger amount. All in all, flexibility is assumed to cost about 10% extra, and the question is whether the switch option is worth this amount.

In order to answer this questions, the following assumptions have been made:

- The net present value of future rents is always equal to the sales price, both for office space and residential property.
- An office building in the segment lasts 10 years.
- A residential building can be transformed after 2, 4, 6, or 8 years.

B. *Results*

Combining the assumptions above with the parameters estimated in Section II, results were obtained as displayed in Table 5. The net value of the switch option is evaluated for correlation coefficients of 0,13 and 0,68 for office rent and house price developments, and for a ‘high ceiling markup’ of 5% and 10%.

Table 5 Net value of switching a residential building into an office building after *T* years (million euro)

***T* = 2**			***T* = 6**	
High ceiling markup	5%	10%	5%	10%
Correlation coefficient				
0.13	-1.9	0.4	6.3	8.6
0,68	-2.7	-0.5	5.7	8.0
***T* = 4**			***T* = 8**	
High ceiling markup	5%	10%	5%	10%
Correlation coefficient				
0.13	2.5	4.7	9.7	12.0
0,68	1.6	3.9	9.3	11.5

Looking at the values in Table 5, the following observations can be made:

- A transformation after only two years is unlikely to be valuable at the present bandwidth of the parameters.
- After a longer time, development between the housing market and the market for offices can diverge, which adds value to the switch option.

- After a longer time, the bonus residents are assumed to be prepared to pay for a higher ceiling becomes less crucial: the option to switch becomes more important.
- A weaker correlation between the office market and the housing market (0,13) increases the value of the switch option substantially.

V. CONCLUDING REMARKS

According to the calculations presented in this paper, the option to postpone construction can be valuable, but the optimal period is only one year. This calculation assumes that an office building can always be let directly after completion.

The option to transform apartments into office space was found to be valuable if the switch takes place after 4 or more years. Though potentially interesting for property planners, two practical issues should be borne in mind. First, office space is known to have a relatively short life-time in the top segment. This life-time is likely to be shorter if a building is used for residential purposes first. This in turn would lower the value of the switch option. Second, it will in practice be hard to remove all residents from a building after a few years. Altogether, transforming office space into apartments seems more likely than the other way around. This seems to be possible at relatively low costs.

ACKNOWLEDGMENT

The authors thank Stichting Atlas voor Gemeenten for supplying data on office rents and house prices in Dutch municipalities.

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