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Regressed DCF, Real Estate Value, Discount Rate and Risk Premium Estimation. A case in Bucharest*

Discounted Cash Flow Analysis is a method used for real estate valuation and valuation of worth. The application of DCF requires the selection of an appropriate discount rate. Discount rate estimation is based on the sum between a risk free and a risk premium. A different approach is the selection of an IRR of comparable projects. The work tests the regressed DCF as a model of valuation. The method is based on regressed DCF recently proposed (D'Amato and Kauko, 2011) relies on deriving risk premium in a specific urban context starting from a small sample of DCF used to appraise commercial property in the same urban context. Therefore it will be used regressed DCF as discount rate and risk premium estimation. The area interested by the empirical application is near Bucharest.

Introduction

Discounted Cash Flow Analysis for real estate valuation is a valuation technique "*…where a discount rate is applied to a series of cash flows for future periods to discount them to a present value…*" (IVS 2011; IVS Framework). Regressed DCF is a model which tries to explore the mathematical relationship between inputs and outputs of DCF. It has been recently proposed (D'Amato and Kauko, 2012) as a way to calculate discount rate and risk premium. The paper is based on the application of regressed DCF as a valuation method and as method to determine the discount rate and the risk premium. This method works on small sample of observations. While the first application of regressed DCF models was based on a casually generated sample, this works represents the first empirical test of the model to a small sample of data collected in Bucharest. Regressed DCF is a group of three models dubbed A, B and C analysing the mathematical relationship among DCF inputs and outputs. This paper tests the application of model A regressed DCF to a small sample of DCF in Bucharest.

* Although the paper was written in strong cooperation between the authors it is possible to assign the Introduction and the first paragraph to prof. Ion Anghel while the second paragraph and the conclusions to prof. Maurizio d'Amato.

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1. Discounted Cash Flow Analysis, Discount Rate Determination, Regressed DCF

When valuing office/business parks, hotel properties, larger retail centers an other income producing properties, DCF receives the greatest weight because those properties are bought and sold based on their income-producing potential, they are typically purchased for investment rather than for owner occupancy. DCF assumptions may significantly influence the final value estimates, therefore using the proper assumptions is the most important ingredient in the quality of DCF estimates.

One school of appraisal thought is that market value can and should be explained only by the transaction market. The result is the three approaches are not independent and become another way to analyze the transaction market. In stable market conditions this solution is reliable. From the theory point of view into an unstable market or in a period with lack of current transactions is not proper for this approach. So the other school of valuation considers all three approaches to estimate independent the property market value and increase the importance of reconciliation step in the valuation process.

DCF analysis is a methodology to estimate real estate valuation and valuation of worth. According to Baum et al. (1996) it is possible to distinguish market prices as the sum that was actually paid for an asset. Valuation is the activity of estimating the most likely selling price or *'market value'*, while assessment of worth is the estimation of investment value. It is possible to distinguish an individual worth as the maximum bid price of an individual purchaser who takes all the available market information in an efficient way. On the other side market worth is the price at which an investment would trade in a market where buyers and sellers collect market information in an efficient way. The method consists in discounting several cash flows belonging to the same temporal interval dubbed holding period. Finally, a direct capitalization (scrap value, exit value, going out value) is discounted from the end of holding period in order to consider future rents.

Several works concerning DCF methodology analysed different aspects of the method, with pioneering contributions by Downs (1966), Ratcliff (1972) and Dilmore (1971). Several issue have been highlighted as uncertainty (French and Cooper, 2000); the importance of developing a reliable cash-flow analysis (Willison, 1999); and the influence of vacancy and market analysis (Rabianski, 2002). Other recent contributions have highlighted the sensitivity of inputs on the final output (Taylor and Rubin, 2002; Wheaton et al., 2001; Hendershott and Hendershott, 2002). In this method the determination of discount rate plays a strategic role for the application of discounted cash flow analysis. International Valuation Standards 2011 suggest (IVSC,2011,IVS 230 Valuation Real Property Interest):

> *"C.19 The yield or discount rate discussed above will be determinated by the objective of the valuation. If this is to estabilish the value to a particular owner or potential owner based on their own investment criteria, the rate used may reflect their required rate of return or the weighted average cost of capital. If it is to es-*

tabilish the market value, the rate will be derived from observation of the returns implicit in the price paid for real property interests traded in the market between market participants.
C.20 The appropriate discount rate should be determined from analysis of the rates implicit in transactions in the market. Where this is not possible an appropriate discount rate may be built up from a typical risk free return adjusted for the additional risks and opportunities specific to the particular real property interest".

Therefore it is possible to distinguish two possible alternatives to determine discount rate: the former is the selection of internal rate of return related to "traded in the market between participants" or "transactions in the market". The latter will be the sum between a risk free return and additional risk premium (Hoesli and Macgregor, 2001; Lusht, 1997). Normally the risk free term can be calculated as the gross redemption yield on conventional gilts which have the same length of property investment. The risk premium is allowed to vary depending on the characteristic of the property investment. In the assessment of individual worth of an investment this term may vary across different investors. A similar process can be applied also in property valuation. In Italy IPD Nomisma valuation guidelines suggested a quantification included in an interval between 0 and 8 percentage points.

Regressed DCF is a valuation technique for discount rate and risk premium determination. The method was applied to several DCF applied in Bucharest area. Bucharest area represents the major part of real estate investment in Romania. Office stock is around 1.430.000 sqm with an average vacancy rate around 18% (lower in the central area) and prime Headline Rent 19 euro/sqm/month. Table 1 below offers vacancy and rent level in the segment of office market in Bucharest:

Table 1. Bucharest office market overview Vacancy and Rent Level in Bucharest - Office Market.[1]

Area	Vacancy	Rent Level (average E/sqm/m)
CBD	12%	17,0 - 19,5
Center	12%	15,5 - 18,5

Regarding retail market - shopping centers total surface is 452.000 sqm in Bucharest (around 44% from the entire country) with an average vacancy rate around 8% (versus 13% the rest of the country) and average rent around 50-70 euro/sqm/month. Retail market – high street is influenced by the competition between luxury brands, banks, pharmacies, restaurants, coffee shops et similia. Table 2 indicates vacancy and rent level in this market:

[1] CBRE, Market view, Bucharest office, Q3 2011, http://portal.cbre.eu/portal/page/portal/research/publications/FPR_EMEA_BUCHAREST_OFFICE_MV_Q3_2011.pdf

Table 2. Bucharest High street retail market overview Vacancy and Rent Level in Bucharest – High Street Retail.[2]

Area	Vacancy	Rent Level (average euro/sqm/m)
Center	5%	50-75
Semi – Center	10%	20-35
Periphery	13%	8-25

The observations considered in our analysis considered five office properties (multi tenant) in CBD area and six high street retail properties in central or semi-central area. All transactions considered are relatively recent.

2. An application of regressed DCF in Bucharest

The list of the sample of 11 observations is indicated in the table 3 below:

Table 3. 11 DCF inputs in Bucharest.

Nr.	PRICE (DCF) Price	NET OPERATE INCOME NOI	GOING IN CAP RATE GICR	DISCOUNT RATE DR
1	€ 2.736.842,00	€ 168.174,00	0,061	0,100
2	€ 46.000.000,00	€ 3.902.046,00	0,085	0,105
3	€ 72.445.667,96	€ 6.766.326,80	0,093	0,105
4	€ 3.000.000,00	€ 188.350,00	0,063	0,100
5	€ 1.485.000,00	€ 138.000,00	0,093	0,108
6	€ 340.000,00	€ 30.000,00	0,088	0,105
7	€ 530.000,00	€ 49.200,00	0,093	0,108
8	€ 200.000,00	€ 24.000,00	0,120	0,135
9	€ 228.000,00	€ 19.200,00	0,084	0,100
10	€ 850.000,00	€ 54.000,00	0,064	0,090
11	€ 480.000,00	€ 42.000,00	0,088	0,090

The prices indicated with the acronym PRICE are in euro. The rent indicated as NOI which are indicated in the contract. The going in cap rate is indicate with

[2] Colliers International, 2011 Mid Year Romanian Real Estate Overview, http://www.colliers.com/Country/Romania/?lang=en

the acronym GICR. It is the cap rate that can be used in a direct capitalization, at moment of valuation. The discount rate is indicated as DR and is used to estabilish an indication of the present value of the income stream associated with a property. The small sample has the following descriptive statistics in the table 4:

Table 4. Descriptive Statistics of 11 DCF-Observations in Bucharest.

	Mean	St.Dev	Min	Max
Price	€ 11.663.228,18	€ 24.265.555,65	€ 200.000,00	€ 72.445.667,96
NOI/year	€ 1.034.663,35	€ 2.220.924,99	€ 19.200,00	€ 6.766.326,80
GICR	0,08	0,02	0,06	0,12
DR	0,10	0,01	0,09	0,14

To this small sample was applied one of the three models of regressed DCF (D'Amato and Kauko, 2012). In particular the model applied is the model A. The relationship between inputs and outputs in the model A is indicated in the formula 1 below:

$$PRICE = DCF(Y) = LOC \cdot NOI^{b_1} \cdot \frac{1}{(GICR \cdot DR)^{b_2}} \tag{1}$$

In log terms the formula 2:

$$\ln(PRICE) = \ln(LOC) + b_1 \ln(NOI) - b_2 \ln(GICR \cdot DR) \tag{2}$$

In order to apply the model A the variables have been recalculated in the following table 5.

In the original work (D'Amato and Kauko, 2012) a regression model log log was applied. In the table 6 below, the log of the data have been calculated in order to linearise the model.

In the table 7 below it is possible to observe the mean and standard deviation of each variable.

All the data have been standardized in using the formula n. 3 below:

$$z = \frac{x - \mu}{\sigma} \tag{3}$$

Standardization is a statistical technique (Gelman,2007) to give equal weight to all the variables of the model. The new standardized variables are indicated in the Table 8.

Table 5. Calculation of Variables.

Price	NOI	1/(GICR.DR)
€ 2.736.842,00	€ 168.174,00	162,73871110
€ 46.000.000,00	€ 3.902.046,00	112,27321208
€ 72.445.667,96	€ 6.766.326,80	101,96946776
€ 3.000.000,00	€ 188.350,00	159,27794001
€ 1.485.000,00	€ 138.000,00	99,63768116
€ 340.000,00	€ 30.000,00	107,93650794
€ 530.000,00	€ 49.200,00	99,92910690
€ 200.000,00	€ 24.000,00	61,72839506
€ 228.000,00	€ 19.200,00	118,75000000
€ 850.000,00	€ 54.000,00	174,89711934
€ 480.000,00	€ 42.000,00	126,98412698

Table 6. Calculation of logarithm.

	PRZ	NOI	1/(GICR DR)
1	14,8223	12,0328	5,092145915
2	17,6442	15,1770	4,720935294
3	18,0983	15,7275	4,624673433
4	14,9141	12,1461	5,070650727
5	14,2109	11,8350	4,601540418
6	12,7367	10,3090	4,681543165
7	13,1806	10,8036	4,604461004
8	12,2061	10,0858	4,122744037
9	12,3371	9,8627	4,777020443
10	13,6530	10,8967	5,164197912
11	13,0815	10,6454	4,844062094

Table 7. Calculation of mean and standard deviation.

MEDIA	14,26	11,77	4,75
DEV.ST	2,00	1,98	0,29

Table 8. Standardized Variables.

	PRZ	NOI	1/GICR*DR
1	0,280	0,131	1,151
2	1,689	1,722	-0,116
3	1,916	2,000	-0,444
4	0,326	0,188	1,078
5	-0,026	0,031	-0,523
6	-0,762	-0,742	-0,250
7	-0,540	-0,491	-0,513
8	-1,027	-0,855	-2,157
9	-0,961	-0,968	0,075
10	-0,304	-0,444	1,397
11	-0,590	-0,571	0,304

Therefore a multiple regression analysis was runned in order to define a mathematical relationship between the small sample of 11 observations. The result of the multiple regression analysis is indicated in the table 9 below:

Table 9. MRA Output on Regressed DCF.

	LOC	NOI	1/(GICR*DR)
Coefficients	-0,0042912	0,9879310	0,0936552
Adj R^2	-0,999		
F	6682,815		
t – Student - Gossett	-0,4923	113,950	9,993

No multicollinearity and endogeneity have been detected. An application of the model to in-sample observations can be considered useful to test its efficency. One of the measure which can be used is mean absolute percentage error indicated in the formula n.4 below:

$$MAPE = \sum_{i=1}^{n} \frac{\left| \frac{PS_i - AS_i}{AS_i} \right| \cdot 100}{n} \tag{4}$$

In the table 10 below the first column is dedicated to actual prices observed (estimated with DCF). The second column indicates the application of the model.

The log log model was subjected to a process of standardization of variables. In the third column the data have been destandardized. Therefore in the fourth column were calculated the predicted prices and finally was calculated the percentage error. In the last column it is highlighted the mean absolute percentage error.

Table 10. MRA Output on Regressed DCF.

Comparable Prices	Application of the Model	Destandardization	Predicted Prices	Percentage Error	Mean Absolute Percentage Error
€ 2.736.842,00	0,232505811	14,7278023	€ 2.490.022,44	0,0902	0,0368
€ 46.000.000,00	1,685718012	17,6375192	€ 45.695.904,89	0,0066	
€ 72.445.667,96	1,9301325	18,1269020	€ 74.544.140,04	0,0290	
€ 3.000.000,00	0,282277256	14,8274579	€ 2.750.952,96	0,0830	
€ 1.485.000,00	-0,023152187	14,2159070	€ 1.492.416,30	0,0050	
€ 340.000,00	-0,760477808	12,7395852	€ 340.982,09	0,0029	
€ 530.000,00	-0,537808989	13,1854274	€ 532.547,50	0,0048	
€ 200.000,00	-1,050628008	12,1586274	€ 190.732,54	0,0463	
€ 228.000,00	-0,953067007	12,3539705	€ 231.878,89	0,0170	
€ 850.000,00	-0,312374308	13,6368075	€ 836.354,21	0,0161	
€ 480.000,00	-0,540328288	13,1803831	€ 529.867,93	0,1039	

The final result of the model is a mean absolute percentage error of 0,0368. It seems that regressed DCF may have the potential to foresee the opinion of value determined through discounted cash flow analysis. The model was originally proposed for discount rate estimation. In fact few easy mathematical passages permit to have a methodology for discount date and risk premium estimation. Starting from the following mathematical relation:

$$PRICE = DCF = LOC \cdot NOI^{b_1} \cdot \frac{1}{GICR^{b_2}} \cdot \frac{1}{DR^{b_2}} \tag{5}$$

It is possible to write

$$\ln(PRICE) = \ln(LOC) + b_1 \ln(NOI) - b_2 \ln(GICR \cdot DR) \tag{6}$$

Therefore

$$\ln(DR) = \frac{\ln(LOC) + b_1 \ln(NOI) - \ln(PRICE) - b_2 \ln(GICR)}{b_2} \tag{7}$$

In our case

$$\ln(DR) = \frac{\ln(LOC) + 0,9879310 \ln(NOI) - \ln(PRICE) - 0,0936552 \ln(GICR)}{0,0936552} \tag{8}$$

The in-sample application for discount rate determination gave the results in the table 11:

Table 11. In –sample application of regressed DCF for discount rate determination.

1/(GICR*DR)	NOI	ln (NOI)	ln(PRICE)	ln(GICR)	ln(LOC)	DR Standardized
0,0936552	0,9879310	0,1306	0,28	-1,470	-0,0043	-0,185041396
		1,7216	1,69	0,099		-0,018915585
		2,0002	1,92	0,568		0,028698113
		0,1879	0,33	-1,365		-0,174458442
		0,0305	-0,03	0,543		0,006456467
		-0,7417	-0,76	0,291		-0,025466628
		-0,4914	-0,54	0,538		0,000687889
		-0,8546	-1,03	1,788		0,11649503
		-0,9675	-0,96	0,064		-0,049475927
		-0,4443	-0,30	-1,308		-0,175346683
		-0,5714	-0,59	0,250		-0,027641241

In the table 11 the first column is the hedonic price of instrumental variable 1/(GICR•DR) and the second column indicates the coefficients of variable NOI. Both the coefficients can be read in the table 9. From the third to fourth column it is indicate the logarithm of standardized variables: NOI, PRICE and GICR. The sixth column indicates the value of location variable of the regressed DCF also indicated in the table 7. Finally the last column indicates the results standardised of the application of formula n. 10. Therefore the mean absolute percentage error between actual discount rate and predicted discount rate is indicated in the table 12 below:

Table 12. In –sample application of regressed DCF for discount rate determination. Mean Absolute Percentage Error Calculation.

DR Destandardize	Predicted DR	Comparable DR	Percentage Error	Mean Absolute Percentage Error
-2,287	0,10153323	0,100	0,015332298	0,062104819
-2,269	0,103376551	0,105	0,015461419	
-2,264	0,103911013	0,105	0,010371301	
-2,286	0,101649671	0,100	0,016496711	
-2,267	0,103661009	0,108	0,040175847	
-2,270	0,103303231	0,105	0,016159703	
-2,267	0,103596266	0,108	0,03899568	
-2,255	0,104903787	0,135	0,222934912	
-2,273	0,103034961	0,100	0,030349614	
-2,286	0,101639893	0,090	0,129332143	
-2,270	0,103278904	0,090	0,147543381	

The MAPE applied to discount rate determination gave a mean absolute percentage error of 0.062.

The risk premium can be defined as the difference between the discount rate determined through the regressed DCF and the risk free which has been determined as 0,045 assuming the rent of the rumenian gilt. In the table 13 it is possible to observe a comparison between the risk premium obtained by the 11 comparables indicated in the column n.5 and the risk premium predicted thorugh regressed DCF. As one can see the mean absolute percentage error is 0,11.

It must be stressed that the selection of risk premium has several different methodologies and this may have an influence in the final result.

Conclusions

The first empirical application of regressed DCF to Bucharest real estate market gave interesting results indicated in the table 14 below in term of mean absolute percentage error of an in-sample application of the model:

It is possible to see how the regressed DCF gave interesting results in term of valuation model. Good results in term of discount rate estimation and interesting result as forecasting method of risk premium.

It must be stressed that only one of the three regressed DCF models has been applied. An interesting direction of research could be compare the final output of different regressed DCF models A; B; C. Another interesting direction of research it may be the integration between geographical coordinates with the regressed DCF in order to analyse the relationship between the risk premium estimation and the spatial context.

Table 13. In –sample application of regressed DCF for risk premium determination. Mean Absolute Percentage Error Calculation.

Risk Free	Predicted DR	Risk Premium Predicted	Comparables DR	Risk Premium Comparables	Percentage Error	Mean Absolute Percentage Error
0,045	0,102	0,057	0,100	0,055	0,027876906	0,110045775
0,045	0,103	0,058	0,105	0,060	0,027057483	
0,045	0,104	0,059	0,105	0,060	0,018149777	
0,045	0,102	0,057	0,100	0,055	0,02999402	
0,045	0,104	0,059	0,108	0,063	0,068872881	
0,045	0,103	0,058	0,105	0,060	0,02827948	
0,045	0,104	0,059	0,108	0,063	0,066938444	
0,045	0,105	0,060	0,135	0,090	0,334402368	
0,045	0,103	0,058	0,100	0,055	0,055181116	
0,045	0,102	0,057	0,090	0,045	0,258664287	
0,045	0,103	0,058	0,090	0,045	0,295086761	

Table 14. Mean Absolute Percentage Errors.

IN SAMPLE REGRESSED DCF MAPE		
Regressed DCF price	Regressed DCF discount rate	Regressed DCF risk premium
0,0369	0,0621	0,110046

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