When to Renovate HUDSON ?[1] FEBRUARY 2012

Peter Paulson, the newly appointed chief real options manager (CROM) of MHG, is considering renovating Hudson, the largest hotel in the group. The announced strategy of MHG is to renovate and operate "boutique hotels" which are designed to provide guests with "distinctive lodging and social experiences", in order to increase occupancy levels and "pricing power". Timing of renovation investments is a critical part of this strategy.

Previously CROMs had looked at a group of five MHG hotels, suitable for renovation, Hudson, Morgans, Royalton, Mondrian Los Angeles and Delano South Beach. The last four hotels were renovated in 2006-2008, and all the renovated hotels except for Delano were sold in 2011. There are a total of 1544 rooms for the five hotels, which constitute about one-third of the total rooms managed by MHG as of December 2009. The other hotels managed by MHG are a diverse lot, including two partially owned London hotels, Boston and other Miami hotels, a Las Vegas hotel and casino, and, formerly, a hotel in Scottsdale, which recently immerged from foreclosure.

The flagship hotel, Morgans, opened in 1984, is named after the nearby Morgan Library on the site of the former home of J. Pierpoint Morgan on Madison Avenue, New York. There are 114 rooms, including 30 suites. Facilities include the Living Room, a guest lounge that has a computer and books in one of the suites. Morgans was renovated for $9 million over four months in 2008, including upgrades to the furniture, fixture and equipment, technology upgrades and an upgrade to the lobby.

Hudson is close to Central Park, Columbus Circle, New York City. It was opened as a hotel in 2000, but formerly was the clubhouse of the American Women's Association, originally constructed by J. P. Morgan's daughter. Hudson has 831

[1] (c) This case was prepared by Dean Paxson for the purpose of class discussion only and not as an illustration of either good or bad business practices. The character of Peter Paulson is fictitious. The figures for Hudson and the 5 hotel average are based on prospectuses and 10Ks of MHG over the last decade.

guest rooms and suites, including a 3344 square foot penthouse with a landscaped terrace, and an apartment with a 2500 square foot terrace. Several plans for enhancement and enlargement of Hudson have been announced, and the primary restaurant was “re-concepted and renovated” in 2009.

Royalton has 168 rooms and suites, 37 with working fireplaces, and is near Times Square. Royalton was renovated (and “re-thought”) for $17.5 million over four months in 2007. Delano South Beach, Miami, has 194 guest rooms, suites and lofts, an indoor/outdoor lobby and a 100-foot long pool. Many rooms in Delano Miami were renovated in 2006-2007, with technology upgrades. Mondrian Los Angeles has 237 guest rooms, studios and suites, located on Sunset Boulevard. There was a renovation costing $40 million in 2008, including lobby renovations, room renovations, the replacement of bathrooms and technology upgrades.

The multi-factor renovation problem is to find a $\hat{R}$ given $\hat{C}$ (the RevPAR level R at which a renovation decision should be made, if the CostPAR level equals $\hat{C}$), which is a solution to a small set of simultaneous equations. Other specific renovation models are based on limiting assumptions: the deterministic net present value (NPV) model assumes all inputs are constant; and the single renovation model assumes only one renovation is possible. There are analytical solutions for all of these renovation models.

1. Multiple Renovation Model

Some textbooks on hotel investment and renovation such as Ramsley and Ingram (2004) and Jones, Lockwood and Mogendorff (2006) adopt the deterministic approaches.

Stochastic single-factor models for developing properties are provided by Patel and Paxson (1998) (numerical solutions) and Paxson (2005) (analytical solutions), and also Paxson (2007) for sequential improvements. Many real property option models are summarized in Patel, Paxson and Sing (2005), including funding lease arrangements which may have minimum renovation/maintenance requirements.

Adkins and Paxson (2011) provide a quasi-analytical implicit solution to a two-factor real option renewal model without having to reduce the dimensions. This approach requires as the critical drivers of periodic renovations, the current revenue and cost levels and expected volatilities and correlation plus expected post-renovation revenue and costs in order to make appropriately timed renovation decisions.

All the key quantities in the model are expressed on a per available room basis. For an all-equity hotel firm with no other revenues or costs, and ignoring taxes, the annual RevPAR is denoted by R and the annual CostPAR by C, so the yearly net cash flow per available room is $R-C$. Since amenities decline in quality due to usage, and consequently R and C deteriorate, hotels are obliged periodically to renovate their premises in order to restore market perceptions and competitiveness. It is assumed that for the hotel in question, renovation leads to significantly improved levels for R and C, denoted by R_I and C_I, respectively. The renovation investment cost is denoted by K, assumed to be constant[2]. Any residual salvage value for the hotel amenities at renovation, possibly old furniture and fittings, is treated as zero, or at least deterministic and absorbed in K.

The two uncertain factors, R and C, are assumed to be well described by geometric Brownian motion processes with drift. For $X \in \{R,C\}$:

$$\mathrm{d}X = \alpha_X X\mathrm{d}t + \sigma_X X\mathrm{d}Z_X \,, \tag{1}$$

where α_X is the instantaneous drift rate, σ_X is the instantaneous volatility rate, and $\mathrm{d}Z_X$ is the increment of a standard Wiener process. Since hotel amenities deteriorate with usage, we would expect α_R to be negative and α_C to be positive.

[2] K is treated as a variable dependent on the improvement differential in Adkins and Paxson (2012).

Dependence between the two uncertain variables is described by the instantaneous covariance term $\rho\sigma_R\sigma_C$ where $\text{Cov}\left[\text{d}R,\text{d}C\right]=\rho\sigma_R\sigma_C RC\text{d}t$ with $\left|\rho\right|\leq 1$.

The hotel value, which includes the embedded renovation option, is denoted by the valuation function F. As the hotel value depends on R and C, $F=F\left(R,C\right)$. Standard contingent claims analysis can be applied to the property with value F to determine its risk neutral valuation relationship. This is expressed as the two-dimensional partial differential equation:

$$\begin{aligned}&\tfrac{1}{2}\sigma_R^2R^2\frac{\partial^2F}{\partial R^2}+\tfrac{1}{2}\sigma_C^2C^2\frac{\partial^2F}{\partial C^2}+\rho\sigma_R\sigma_C PC\frac{\partial^2F}{\partial R\partial C}\\&\qquad+\theta_R R\frac{\partial F}{\partial R}+\theta_C C\frac{\partial F}{\partial C}-rF+\left(R-C\right)=0,\end{aligned}\tag{2}$$

where θ_X denote the risk-adjusted drift rates, r=riskless interest rate. Assume r-θ_X >0, and $\alpha_X=\theta_X$. The solution to (2) is as in Adkins and Paxson (2011):

$$F=AR^{\beta}C^{\eta}+\frac{R}{r-\theta_R}-\frac{C}{r-\theta_C}\,,\tag{3}$$

with coefficient A and parameters β and η. The function F is composed of two elements. The term $AR^{\beta}C^{\eta}$ is interpreted as the renovation option, which being non-negative means $A\geq 0$. The second element $\frac{R}{r-\theta_R}-\frac{C}{r-\theta_C}$ represents the hotel value in the absence of optionality. Substituting F in (2) demonstrates (3) as the solution and yields the characteristic root equation:

$$Q\left(\beta,\eta\right)=\tfrac{1}{2}\sigma_R^2\beta\left(\beta-1\right)+\tfrac{1}{2}\sigma_C^2\eta\left(\eta-1\right)+\rho\sigma_R\sigma_C\beta\eta+\theta_R\beta+\theta_C\eta-r=0\,.\tag{4}$$

The limiting boundary conditions impose additional conditions on the form of F. Renovation becomes economically justified for a sufficiently low RevPAR and sufficiently high CostPAR such that the resulting incremental net revenue due to renovation more than adequately compensates for the renovation cost. These requirements are reflected in the renovation option value, which intensifies in value for increasingly low RevPAR and increasingly high CostPAR. This suggests that the power parameter β for R is negative, while the power parameter η for C is positive.

The respective threshold levels for RevPAR and CostPAR are determined such that an optimal renovation is signalled as soon as the prevailing pair of RevPAR and CostPAR levels simultaneously attain their respective thresholds. The threshold levels are obtained from the economic boundary conditions for value conservation and optimality. For an optimal renovation to be signalled, the value for the hotel in the current state has to be exactly balanced by its net value in the improved state. At renovation, the hotel value is specified by $F\left(\hat{R},\hat{C}\right)$. Immediately following the renovation, the hotel value now in its improved state is given by $F\left(R_I,C_I\right)$.

Value is conserved immediately before and after an optimal renovation when:

$$A\hat{R}^{\beta}\hat{C}^{\eta}+\frac{\hat{R}}{r-\theta_R}-\frac{\hat{C}}{r-\theta_C}=AR_I^{\beta}C_I^{\eta}+\frac{R_I}{r-\theta_R}-\frac{C_I}{r-\theta_C}-K \tag{5}$$

Associated with the value matching relationship (5), there are two first order optimality conditions, one for each of the factors R and C, which are referred to as the smooth pasting conditions, that can be expressed (when simplified) as:

$$A=-\frac{\hat{R}}{\beta\left(r-\theta_P\right)}\times\frac{1}{\hat{R}^{\beta}\hat{C}^{\eta}}=\frac{\hat{C}}{\eta\left(r-\theta_C\right)}\times\frac{1}{\hat{R}^{\beta}\hat{C}^{\eta}} \tag{6}$$

Clearly $A\geq 0$ as required, since $\beta<0$ and $\eta>0$. Re-arranging and simplifying (6), the reduced form smooth pasting condition is:

$$\frac{\hat{R}}{-\beta\left(r-\theta_P\right)}-\frac{\hat{C}}{\eta\left(r-\theta_C\right)}=0 \tag{7}$$

Using (6) to eliminate A, the value matching relationship (5) can be expressed as:

$$\frac{\hat{R}}{r-\theta_P}-\frac{\hat{C}}{r-\theta_C}+\frac{\hat{C}}{\eta\ (r-\theta_C)}\left\{1-\frac{R_I^{\beta}C_I^{\eta}}{\hat{R}^{\beta}\ \hat{C}^{\eta}}\right\}-\frac{R_I}{r-\theta_P}+\frac{C_I}{r-\theta_C}+K=0. \tag{8}$$

Eliminating $\hat{R}$, this can be expressed as:

$$\frac{\hat{C}}{\eta\ (r-\theta_C)}\left(1-\beta\ -\eta\ -\frac{R_I^{\beta}\ C_I^{\eta}}{\hat{C}^{\beta\ +\eta}}\left(\frac{-\beta\ (r-\theta_P)}{\eta\ (r-\theta_C)}\right)^{-\beta}\right)$$

$$-\frac{R_I}{r-\theta_P}+\frac{C_I}{r-\theta_C}+K=0. \tag{9}$$

The characteristic root equation (4), the reduced form value matching relationship (9) and the reduced form smooth pasting condition (7) constitute the two-factor renovation model from which the discriminatory boundary is generated. To determine the boundary, solve these three equations (set equal to zero) simultaneously, by changing β, η and $\hat{R}$ corresponding to some assumed $\hat{C}$.

The valuation function is:

$$F=(\frac{R}{\hat{R}})^{\beta}(\frac{C}{\hat{C}})^{\eta}\frac{\hat{R}}{-\beta(r-\theta_R)}+\frac{R}{r-\theta_R}-\frac{C}{r-\theta_C} \tag{10}$$

2. Restricted Renovations

Suppose that there are a finite number of renovation opportunities, due to design innovations, or locational transformations or structural deterioration. $F_J(R,C)$ denotes the incumbent asset value when J further renovation opportunities are available. For $J=1$, one further renovation opportunity remains, after which the only available opportunity is abandonment.

2.1 Single Renovation Option

When there is only one remaining renovation opportunity so $J=1$, the solution is derived directly from the model with multiple opportunities by eliminating the renovation option from the multiple renovation property value. Using the subscript

s to denote the single renovation opportunity, then from (5), the value matching relationship becomes:

$$A_s \hat{R}_s^{\beta_s} \hat{C}_s^{\eta_s} + \frac{\hat{R}_s}{r-\theta_R} - \frac{\hat{C}_s}{r-\theta_C} = \frac{R_I}{r-\theta_R} - \frac{C_I}{r-\theta_C} - K \ . \qquad (11)$$

It follows that the two smooth pasting conditions associated with (11) imply (7). By substituting and rearranging, the reduced value matching condition is:

$$\frac{\hat{R}_s}{r-\theta_R}\left[\frac{\beta_s - 1}{\beta_s}\right] - \frac{\hat{C}_s}{r-\theta_C} - \frac{R_I}{r-\theta_R} + \frac{C_I}{r-\theta_C} + K = 0 \qquad (12)$$

The smooth pasting condition is:

$$\frac{\hat{R}_s}{-\beta_s\left(r-\theta_R\right)} - \frac{\hat{C}_s}{\eta_s\left(r-\theta_C\right)} = 0. \qquad (13)$$

The single renovation boundary is evaluated by solving the three simultaneous equations: the reduced form value matching relationship (12), the reduced form smooth pasting condition (13) and the characteristic root equation (4).

The renovation boundaries for the cases of an infinite number of renovation opportunities and a single renovation opportunity are vertically stacked: the boundary for the infinite renovation model entirely lies above that for the single renovation model. For every operating cost threshold level, $\hat{R}_\infty > \hat{R}_s$. This means that the trajectory of prevailing revenue and operating cost levels, starting from their respective initial levels R_I and C_I at renovation, will always hit the infinite renovation boundary first before reaching the single renovation. Provided that R_I and C_I remain unaltered during the property lifetime, a critical strong assumption, the infinite renovation policy always dominates the other policy.

2.2 Deterministic Renovation Model

Using T* to denote the optimal deterministic timing, the first order condition for the maximum NPV for an infinite chain of property embedded renovation opportunities with a constant renovation interval T* simplifies to:

$$\hat{R}\left(\frac{1}{r}+\frac{\theta_R}{r}\times\frac{e^{-r\hat{T}}}{r-\theta_R}\right)-\hat{C}\left(\frac{1}{r}+\frac{\theta_C}{r}\times\frac{e^{-r\hat{T}}}{r-\theta_C}\right)-\frac{R_I}{r-\theta_R}+\frac{C_I}{r-\theta_C}+K=0 \tag{14}$$

Using the subscript d to denote the deterministic version of the general renovation model, $T^*=\hat{T}$, where the optimal cycle time is:

$$\hat{T}=\frac{1}{\theta_C}\ln\left(\frac{\hat{C}_d}{C_I}\right)=\frac{1}{\theta_R}\ln\left(\frac{\hat{R}_d}{R_I}\right) \tag{15}$$

$$\theta_R\beta_d+\theta_C\eta_d-r=0\,, \tag{16}$$

$$\left(\frac{R_I}{\hat{R}_d}\right)^{\beta}\left(\frac{C_I}{\hat{C}_d}\right)^{\eta}-e^{-r\hat{T}}=0 \tag{17}$$

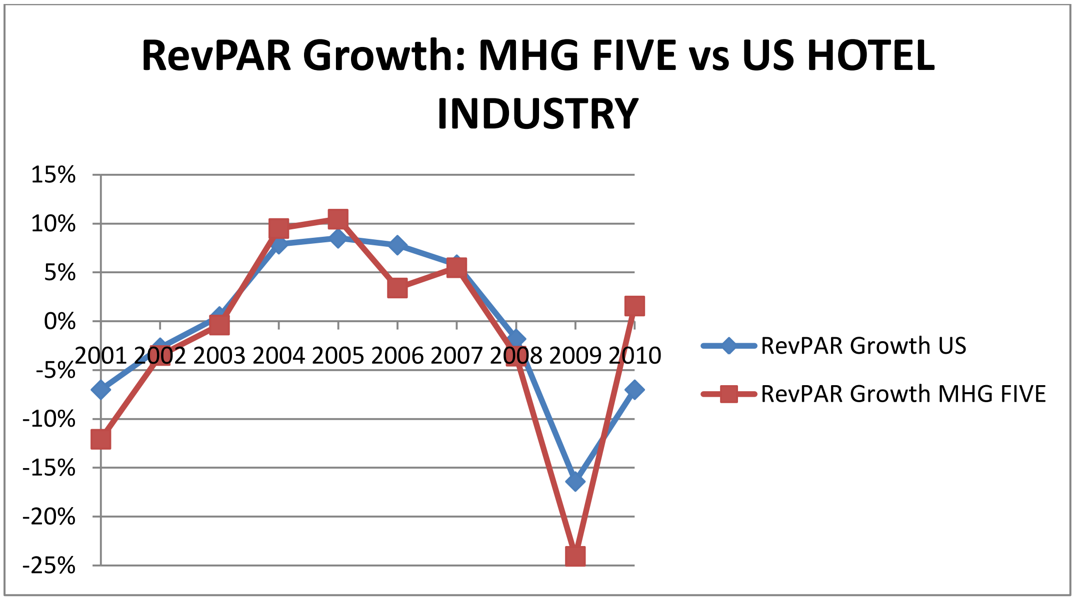
2.3 Solving Sets of Equations to Find $\hat{R}$

Table 1 shows the RevPAR and CostPAR for MHG five hotels over the last decade. Note that the maximum profit per available room was achieved in 2006, so it is assumed that any renovations would bring R and C back to those levels. The growth of R and C are calculated as ln (R_{t+1}/R_t) and ln (C_{t+1}/C_t), MEAN is the average of those series, STDEV is the annual standard deviation of those growth series, and the CORREL the correlation of the growth series.

Table 1

FIVE HOTELS														
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010			
TOTAL RevPAR	**452.78**	**401.30**	**387.51**	**386.06**	**424.56**	**471.38**	**487.76**	**515.30**	**497.25**	**390.93**	**397.12**			
OP COST PAR	**329.58**	**304.67**	**305.79**	**309.20**	**328.17**	**339.64**	**341.38**	**374.77**	**390.17**	**369.15**	**369.14**			
PROFIT PER AVAILABLE ROOM	123.20	96.63	81.72	76.86	96.39	131.74	146.38	140.52	107.08	21.79	27.98	MEAN	STDEV	CORREL
RevPAR Growth MHG FIVE		-12.07%	-3.50%	-0.38%	9.51%	10.46%	3.42%	5.49%	-3.57%	-24.05%	1.57%	**-1.31%**	**10.42%**	**78.30%**
CostPAR Growth		-7.86%	0.37%	1.11%	5.95%	3.44%	0.51%	9.33%	4.03%	-5.54%	0.00%	**1.13%**	**5.07%**	

Figure 1



Notice that the performance of MHG five hotels slightly exceeded that of the general U.S. hotel industry for only two years of the decade, but sharply underperformed the industry right after major renovations for most hotels in 2006-2008. There has been a sharp recovery over the last year, perhaps a delayed response to the renovations, or in general a recovery of the luxury hotel sector. The RevPAR volatility over the decade of the five hotel aggregate is about 20% higher than the US hotel industry, and the RevPAR downward drift about three times greater than for the US general hotel industry.

The optimal renovation $\hat{R}$ is determined for a particular $\hat{C}$ using the base case [INPUT] in Figures 2, 3 and Table 1. K is the average renovation cost per room for the four hotels that were renovated during 2006-2008. In order to compare the general two stochastic factor case with the conventional deterministic case, first the deterministic results are calculated in Figure 2. Simultaneously solving equations (14), (16) and (17), with the constraint (15), renovation is justified when $\hat{R}$ falls to $431 (from $488) if $\hat{C}$ has increased to over $380 (from $341). Assuming deterioration occurs at the end of the year, R would have declined to 433 and C increased to 378 at the end of the ninth year, so the trigger spread justifying a renovation is reached. The NPV at the renovation optimal R* and C* is equal to the renovation cost of 336.

Figure 2

	A	B	C	D	E	F	G	H	I	J	K
1	**FIVE HOTEL DETERMINISTIC RENOVATION MODEL**										
2	INPUT	**Deterministic**									
3	R_I	$487.76	2006 TOTALRevPar								
4	C_I	$341.38	2006 COST								
5	K	336.41									
6	C*	380.05									
7	σ_R	0.00									
8	σ_C	0.00									
9	ρ	0.00									
10	r	0.10									
11	θ_R	-0.0131									
12	θ_C	0.0113									
13											
14	OUTPUT										
15	$Q(\beta,\eta)$	0.0000									
16	SP	0.0000									
17	VM	0.0000									
18	SUM	0.0000									
19	β	-2.6716									
20	η	5.7295									
21	R*	430.829									
22	C*	380.047									
23	T^*_C	**9.463**									
24	T^*_R	9.463									
25	R*-C*	50.782									
26											
27	Deterministic										
28	$Q(\beta,\eta)$	B11*B19+B12*B20-B10				EQ 16					
29	SP	((B3/B21)^B19)*((B4/B22)^B20)-EXP(-B10*B23)				EQ 17					
30	VM	B35-B36-B37				EQ 14					
31	SOLVER	SET B18=0,CHANGING B19:B22,B23=B24									
32	T^*_C	(1/B12)*(LN(B22/B4))				EQ 15					
33	T^*_R	(1/B11)*(LN(B21/B3))				EQ 15					
34											
35	R* VALUE	4114.39				EQ 14					
36	C*VALUE	3989.13				EQ 14					
37	Renewal V-K	125.26				EQ 14					
38	NPV=0	0.0000				EQ 14					
39	R* VALUE	B21*((1/B10)+(B11/B10)*(EXP(-B10*B24)/(B10-B11)))									
40	C*VALUE	B22*((1/B10)+(B12/B10)*(EXP(-B10*B24)/(B10-B12)))									
41	Renewal V-K	B3/(B10-B11)-B4/(B10-B12)-B5									
42	NPV=0	B35-B36-B37									
43			**ASSET DETERIORATION OVER THE YEARS**								
44	YEARS	1	2	3	4	5	6	7	8	**9**	10
45	R	481.40	475.13	468.94	462.83	456.80	450.85	444.97	439.18	**433.45**	427.81
46	C	345.27	349.21	353.19	357.22	361.29	365.41	369.58	373.79	**378.06**	382.37
47	R-C	136.13	125.92	115.75	105.61	95.51	85.43	75.39	65.38	**55.40**	45.44
48	R	B3*EXP(B11*B46)									
49	C	B4*EXP(B12*B46)									

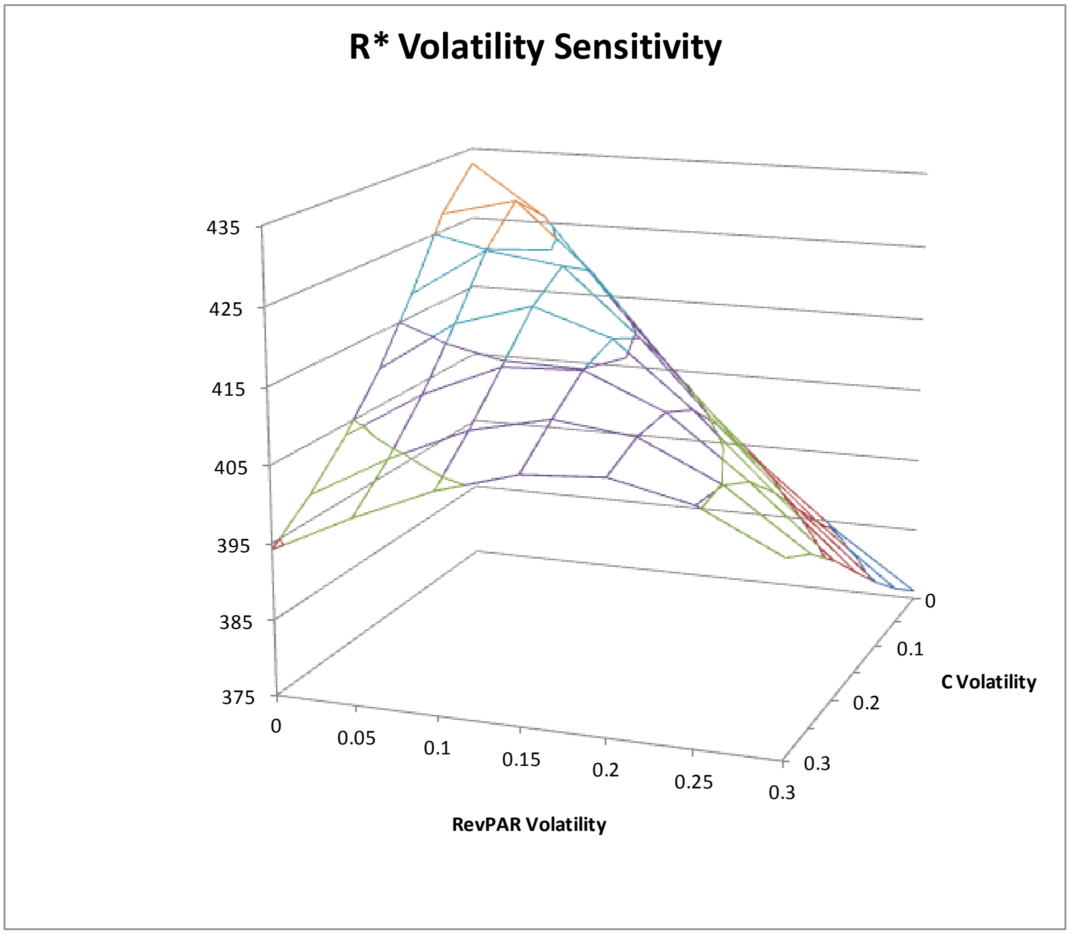
Using $\hat{C}$=380 for the two factor stochastic case, with σ_R = .104 and σ_C =.051, ρ=.78, and solving equations (4), (7) and (9) simultaneously, Figure 3 shows that a renovation would be justified only if R<417. For comparison, the general renovation model setting σ_P=σ_C=0 replicates the deterministic result.

Figure 3

	A	B	C	D	E	F
1	**FIVE HOTEL ROOM RENOVATION MODEL**					
2	INPUT	**DETERMINISTIC**	**Stochastic MULTIPLE**	**Stochastic SINGLE**		
3	R_I	487.76	487.76	487.76		
4	C_I	341.38	341.38	341.38		
5	K	336.41	336.41	336.41		
6	C*	380.05	380.05	380.05		
7	σ_R	0.00	0.104	0.104		
8	σ_C	0.00	0.051	0.051		
9	ρ	0.00	0.783	0.783		
10	r	0.10	0.10	0.10		
11	θ_R	-0.0131	-0.0131	-0.013		
12	θ_C	0.0113	0.0113	0.011		
13						
14	OUTPUT					
15	$Q(\beta,\eta)$	0.0000	0.0000	0.0000		
16	SP	0.0000	0.0000	0.0000		
17	VM	0.0000	0.0000	0.0000		
18	PART 1	4114.39	1351.40	125.26		
19	PART 2	3989.13	0.0927	125.26		
20	PART 3	125.26	-125.26			
21	SUM	0.000	0.000	0.000	0.000	
22	SOLVER SET E21=0, CHANGING B23:D25					
23	β	-2.6716	-2.7290	-2.6458		
24	η	5.7295	3.1719	3.5423		
25	R*	**430.829**	**417.163**	**362.155**		
26	T*	**9.463**	**11.921**	**22.703**		
27	F*		752.864	VALUE AT EXERCISE POINT		
28	F* RenOption		**1351.398**	**Renovation Option Value Stochastic**		
29	PART I		-1351.40			
30	PART II		1.00			
31	PART III		-598.53	OPERATING VALUE AT EXERCISE POINT		
32	F*Deterministic		800.423	VALUE AT EXERCISE POINT		
33	F*D RenOption		**1278.139**	**Renovation Option Value Deterministic**		
34	PART I		-1395.67			
35	PART II		0.92			
36	PART III		-477.72	OPERATING VALUE AT EXERCISE POINT		
37	F RenOp-RenDeter		**73.26**			
38	Stochastic Multiple					
39	$Q(\beta,\eta)$	EQ 4	0.5*(C7^2)*C23*(C23-1)+0.5*(C8^2)*C24*(C24-1)+C9*C7*C8*C23*C24+C11*C23+C12*C24-C10			
40	SP	EQ 7	C25/(-C23*(C10-C11))-C			
41	VM	EQ 9	C18*C19+C20			
42	PART 1	PART 1	C6/(C24*(C10-C12))			
43	PART 2	PART 2	1-C23-C24-((C3^C23)*(C4^C24)/(C6^(C23+C24)))*((-C23*(C10-C11)/(C24*(C10-C12)))^-C23)			
44	PART 3	PART 3	-C3/(C10-C11)+C4/(C10-C12)+C5			
45	Stochastic Single					
46	$Q(\beta,\eta)$	EQ 4	0.5*(D7^2)*D23*(D23-1)+0.5*(D8^2)*D24*(D24-1)+D9*D7*D8*D23*D24+D11*D23+D12*D24-D10			
47	SP	EQ 13	D25/(-D23*(D10-D11))-D			
48	VM	EQ 12	D18-D19			
49	PART 1	PART 1	(D6/(D24*(D10-D12)))*(1-D23-D24)			
50	PART 2	PART 2	D3/(D10-D11)-D4/(D10-D12)-D5			
51	F*	EQ 11	C29*-C30+C31			
52	F* RenOption		**C29*-C30**			
53	PART I		C25/(C23*(C10-C11))			
54	PART II		((C6/C6)^C24)*((C25/C25)^C23)			
55	PART III		(C25)/(C10-C11)-(C6)/(C10-C12)			
56	F*Deterministic		C34*-C35+C36			
57	F*D RenOption		**C34*-C35**			
58	PART I		(B25/(C23*(C10-C11))			
59	PART II		((C6/C6)^C24)*((B25/C25)^C23)			
60	PART III		(B25)/(C10-C11)-(C6)/(C10-C12)			
61	F RenOp-RenDeter		**C28-C33**			

Figure 3 also shows the triggers for a single remaining renovation opportunity. The $\hat{R}$ is much lower than for multiple renovations. Indeed ($\hat{R}$ - $\hat{C}$) <0 before a single renovation is justified, with $\hat{C}$=380, so the issue of multiple versus single (or limited number of) possible renovations is a critical consideration in renovation decisions. Based on the deterministic drifts, T* is almost twice as long.

Figure 4



Peter is particularly concerned about the expected volatility and correlation inputs. It is apparent (assuming correlation equals .78, the base case) that sharp increases in expected R and C volatility significantly reduce $\hat{R}$ as shown in Figure 4.

Finally, as an illustration of the value destroyed by exercising the renovation option too early, Figure 3 also shows the renovation option value at the optimal stochastic multiple $\hat{R}_\infty$ in contrast to exercise at the deterministic $\hat{R}_d$. There is a significant difference in the level of the RevPAR at which it is optimal to make the renovation and there would be significant value destroyed (73.38) by early exercise at the deterministic threshold. If Peter can get the renovation timing right on Hudson, he wondered how much of the increased value he should pay himself for being an alert CROM.

3. Application to HUDSON

Table 2 illustrates the data for the Hudson hotel. Note that the first year inputs are only for part of the year. Peter thought he would calculate the RevPAR and CostPAR growth as ln (R_{t+1}/R_t) and ln (C_{t+1}/C_t). He assumed the mean drift is the mean of each growth series, the volatility is the annual standard deviations of the growth series, and the correlation is the correlation of RevPAR and CostPAR growth.

Table 2

HUDSON									
ROOMS							**STATISTICS**		
834	2005	**2006**	2007	2008	2009	2010			
OCC	0.853	0.876	0.918	0.907	0.838	0.886			
ADR	247	265	284	283	200	213			
RevPAR	211	232	261	257	168	189			
ROOM REV	61673	68106	76610	75722	49853	57360			
NONRM-REV	19220	19977	24661	22067	15810	15444			
TOTAL REV	80893	88083	101271	97789	65663	72804			
OP INC	24756	33807	36800	32885	6329	9564			
OP COST	56137	54276	64471	64904	59334	63240			
PER ROOM									
RevPAR	202.60	223.73	251.67	248.75	163.77	188.43			
OCC*ADR	210.69	232.14	260.71	256.68	167.60	188.72			
NONRM-RevPAR	63.14	65.63	81.01	72.49	51.94	50.73			
TOTAL RevPAR	265.74	289.36	**332.68**	321.24	215.71	239.16			
OP COST PAR	184.41	178.30	**211.79**	213.21	194.91	207.75			
PROFIT PER AVAILABLE ROOM	81.32	111.06	**120.89**	108.03	20.79	31.42			
RENOVATION COST PER ROOM							MEAN	STDEV	CORREL
RevPAR Growth		**8.52%**	**13.95%**	**-3.50%**	**-39.83%**	**10.32%**			
OpCOST Growth		**-3.37%**	**17.21%**	**0.67%**	**-8.97%**	**6.38%**			

Peter assumes that K for Hudson will be about 336 per room, and RevPAR and CostPAR after the renovation will be the same as in 2007, before the financial crisis.

HUDSON: CASE QUESTIONS

I What are the assumptions, limitations and interpretations of the renovation models that Peter should note?

II What are the appropriate R and C drifts, volatilities and correlation for Hudson for use in the model?

III What is the optimal R and C to renovate Hudson, and considering the last renovation was in 2000, what is the appropriate year of renovation based on the deterministic, single and multiple models?

IV At what value should Hudson be sold now, or at the time of renovation, and what is the appropriate marketing for promoting this value?

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