

Université Libre de Bruxelles
Faculté SOCO
2007-2008

Final Exam

Preliminary session

Form A

Saturday 12 January 2008

Indications

Please follow these indications:

1. The exam lasts 3 hours and contains 30 points.
2. Please verify that your document contains exactly 10 pages.
3. Questions may have a weight different of 1 point each in some cases.
4. Please write your firstname and lastname on the first page.
5. Good work!!!

Problems

P1 Valuing opportunities...

Matthew Mackenzie, CEO of MattMack & Co, a big conglomerate, is considering spinning-off an IT department of the firm, ITtools, to divest from it. This IT department has been providing IT solutions to the group for 10 years now. The board of MattMack & Co. thinks that they could amortize their investment by exploiting the products developed. He has been presenting the new company project to two types of investors: another IT company (SandTech) and a private equity house (PEpartners).

SandTech would be interested in ITtools because their products would be perfectly complementary. PEpartners see it more as a project that is not currently tremendously profitable but the technologies provided by ITtools may give rise to new applications in the future and therefore be highly valuable.

Here is some data about ITtools (in '000 €) and today is January 1, 2008:

- Annual free cash flows just reported for end 2007: 3'000
- The analysts of the company expect that future annual free cash flows will continue growing at a perpetual rate of 4%.
- But this estimate is quite "volatile". The total sum of discounted expected cash flows as projected by PEpartners shows an estimated volatility of 60%.
- The tax rate is 34% and the riskfree rate is 5%.
- The company wants to keep a D/V ratio of 40%.
- The borrowing cost is expected to remain at 9%.
- The beta of stock returns is 2.5

First Name : _____ Last Name : _____

- Assume the historical equity market premium is 6%

Some more precisions:

- As SandTech and PEpartners have both a full equity capital structure, they would like to value ITtools as if the company was fully financed by equity.

Q1 Compute the cost of equity of ITtools as if they were fully financed by equity. [1 point]

Q2 Compute the value of ITtools for SandTech. [3 points]

Additionally, if PEpartners would be allowed to buy ITtools, as a private equity “opportunity finder”, they would want to sell them directly back in 8 years from now (latest date) if the value they can expect from this sale at that time (year 8) would at least be above:

[the value computed today for the “normal buyer”, like the value computed for SandTech above]

×

(1+required rate of return) during the next 8 years

Q3 How much would be PEpartners ready to pay for ITtools? [3 points]

Hint: use a result of 30'000 for the solution in Q2 of you didn't have a solution.

Q4 Explain the result in Q3 compared to result in Q2. If you didn't obtain any result, please explain why there could be some difference between Q2 and Q3. [2 points]

Q5 Where can a private equity fund also obtain a higher valuation in practice from? [1 point]

Hint: think about what can make the valuation higher in any general DCF valuation, and more precisely under the circumstance that we are doing this valuation for a PE fund.

P2 Ratings and creditworthiness...

Aunt Dahlia is tired from the “highlightened” replies of her sister, Aunt Agatha, about financial markets. She is so famous that she is writing in every edition of “Le Caducée”. One day she was visiting her sister, Aunt Dahlia sneaked in her regular press pile and fell on the following Financial Times article:

Why triple-A ratings are not always top notch

By Aline van Duyn and Saskia Scholtes

Published: January 11 2008 02:00 | Last updated: January 11 2008 02:00

The loss of the US government's top-notch triple-A credit rating, if it ever came to pass, would be a hugely symbolic blow to the status of the world's economic and political powerhouse.

Yet any debate about the merits of the US government's rating must reflect the fact that the triple-A stamp of approval has less and less meaning for investors. The credit crisis triggered by the growth in risky mortgage lending, which has affected banks and investors around the world, has dispelled the myth that a triple-A credit rating is a guarantee of security.

Instead, many of the complex debt structures used in recent years by banks and other financial institutions to disperse the risks associated with lending to people or companies, and which were rated triple-A, proved vulnerable to problems with the assets underpinning them. As a result, there have been hundreds of triple-A bonds, mostly complex structured instruments, downgraded in recent months.

"Triple-A [debt] has been the worst affected part of the market relative to its previously perceived credit quality," said Siobhan Pettit, analyst at Royal Bank of Scotland, in a recent report.

Already there are few companies with triple-A credit ratings. Moody's Investors Service only rates five non-financial companies in the US at the top rating.

In the financial world there are more companies with top ratings, because being a safer credit with a lower chance of defaulting on debt means in theory that interest rates paid to borrow money are lower.

Yet there are many investors, such as pension funds or local governments managing cash needed to pay for schools, who want to invest their money as safely as possible. Some of these investors, including cities in countries as far apart as the US and Norway, have lost money due to unexpectedly risky exposures.

In the government debt markets, which are used to park vast amounts of money in a safe haven and also act as a reference point for other borrowers, the meaning of a top credit rating can be higher than in the corporate world. The US government's debt, for example, is owned by central banks, sovereign wealth funds and other important investors around the world. Some of these investors will place funds only in assets with a top credit rating.

"If you take away the cosmetic of a triple-A rating [for US government debt] you will discover that it is not cosmetic at all," said Dan Fuss, fund manager at Loomis Sayles. "At the margin, buyers will go elsewhere."

Yet even the government debt markets are no strangers to different valuations of triple-A ratings: after the introduction of the common euro currency in Europe, debt issued by countries such as Germany was regarded as safer than that of, for example, Italy, even though their ratings were the same.

Just this week, the diverging values to investors of triple-A-rated companies was highlighted. Warren Buffett's Berkshire Hathaway, which has a large role in the insurance markets, is one of the few US companies with a triple-A rating.

Mr Buffett has recently decided to enter the multi-billion dollar market for insuring bonds issued by municipalities. The bond insurers such as MBIA and Ambac who currently dominate this market have been hit by huge losses due to exposure to securities backed by risky mortgages - and are just about hanging on to their triple-A ratings.

As a result, Mr Buffett was paid a higher premium by a New York municipal borrower to insure its debt than the borrower was willing to pay MBIA or Ambac.

The role rating agencies have played in failing to assess correctly the thousands of complex bonds they rated triple-A has come under scrutiny. In addition, the fact that so many investors are forced to sell assets based on credit ratings changes has prompted concerns about the influence rating agencies wield.

Regulators and politicians have called for a change in the rules. This debate is likely to accelerate, especially if the credit crisis in the US deepens and further triple-A credit ratings bite the dust.

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- Q6** Aunt Dahlia is quite amazed. She always thought that a triple-A rating was indeed a guarantee of security. Explain to her why it is not the case. [1 point]
- Q7** Taking back some notes of her sister, Aunt Dahlia started reading about Merton's model, where corporate default risk is modelled as being driven by the value of assets of a firm falling below some threshold level at maturity, assuming that in this case, firm's assets would be liquidated for some recovery value. But the article talks about "sovereign default". And a country cannot be liquidated, but still can be in default. How would you advise her to model PD and LGD in a sovereign context? Formalise using your creativity. [2 points]
- Q8** Aunt Dahlia then examines a particular paragraph: "...the fact that so many investors are forced to sell assets based on credit ratings changes has prompted concerns about the influence rating agencies wield." Aunt Dahlia is now quite perplex. She has just read about the KMV method where its authors claim that they may have a 6-month lead on the rating change by using their EDF results. If what the paragraph tells is true, what do you think about the models covered so far? Do they account for this issue? Can we still use them? If no or yes, why? What would this mean in terms of modelling? [2 points]

P3 IPOs

Some weeks before their IPO, the CFO of OpTech Inc., a firm specialized in grid computing developments, is seating in his bed, reading the contents of the forthcoming Journal of Finance

(February 2008) and more particularly, the article of Céline Gondat-Larralde and Kevin R. James entitled “IPO Pricing and Share Allocation: The Importance of Being Ignorant”.

In this article, the two authors propose an evolution on Rock’s model (1986) and use some interesting data to provide a test of the underpricing phenomenon, depending on two sampling criteria:

1. “Tech” vs. “Non-Tech” sector, depending on a given firm being in the High Tech industry classification or not.
2. A temporal dimension: Pre-Boom, Boom (Low Boom + High Boom), Post-Boom.

Here is a table presenting some of their results:

Table II
IPO Types

We sort IPOs along a *Tech/NonTech* dimension and a time dimension (*PreBoom*, *Boom*, and *Post-Boom*). We classify an IPO as a *Tech* IPO if SDC assigns that IPO a High Tech Industry classification and as a *NonTech* IPO if SDC does not. We define *Boom* as the years 1995 to 2000, *PreBoom* as the years 1986 to 1994, and *PostBoom* as the years 2001 to 2006. The extremely high number of Tech IPOs during 1999 and 2000, and the extremely high average initial returns on these IPOs, caused us to split the Boom period into a *LowBoom* (1995 to 1998) and *HighBoom* (1999 and 2000) period for Tech IPOs.

IPO Type	Definition	Number	Average Initial Return (%)	Standard Deviation of Initial Returns
NonTech/PreBoom	NonTech, 1986–1994	1346	8.22	15.53
Tech/PreBoom	Tech, 1986–1994	838	12.43	30.15
NonTech/Boom	NonTech, 1995–2000	799	15.53	26.61
Tech/LowBoom	Tech, 1995–1998	819	22.69	37.11
Tech/HighBoom	Tech, 1999–2000	625	74.53	95.22
NonTech/PostBoom	NonTech, 2001–2006	287	13.26	35.31
Tech/PostBoom	Tech, 2001–2006	288	11.54	17.48

OpTech In.c is just in the process of fixing the offering price and this is clearly an important information for them.

Q9 What is the starting argument of Rock (1986), i.e. on which theoretical ground is the underpricing phenomenon explained? Analyse then the table presented above. Relate your analysis to the theoretical background. What can you conclude for the case of the IPO of OpTech Inc and the level of the offering price they should propose? [3 points]

Q10 In which category of the table above do you locate Zetes’ IPO? Why? What does it mean for Zetes if Zetes could have known about this study in advance? You can use the elements presented by Pierre Lambert, CFO of Zetes. [2 points]

The average estimated value of OpTech by market analysts is €35/share, knowing that the values in this sector are actually uniformly distributed in a range [-80%,+80%]. 20% of the potential investors are informed.

Q11 Using Rock’s model, what price should OpTech theoretically propose, leaving apart the special circumstances presented before? [2 points]

Hint: roots of the following equation: $ax^2 + bx - c = 0$ can be obtained through $x_{1,2} = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

P4 Risky debt

You have just been hired as a consultant for the Brussel Consulting Group (BCG), your first mission consists in advising a well known Belgian brewer “HineBev”, who want to split up with some of its assets, and its bank (Daixia). HineBev wants to sell part of its activities to a new company (Newcorp) created for this occasion, this new company will buy the assets by issuing a zero coupon debt of face value \$90 millions due in 2 years.

During the first set up meeting Daixia and HineBev gave you some data about the deal (see below) and asked you to answer some questions they have.

- The value of the assets HineBev will sell to the new company is valued at \$100 millions,
- the volatility of the return of those assets is 40%,
- the risk free rate is 4%,
- the risk premium on the market is 5%,
- this company will not pay any dividend in the future,
- the beta of those assets is 1.2,
- the company does not pay any taxes,
- the assets Newcorp buy will not produce any cash flows after 2 years of activity.

You will first answer the questions of Daixia (to answer the following questions your superior suggest you to use a binomial tree with steps of 1 year):

- Q12** What spread should we ask on this debt? Daixia also wants to know the default probability and the loss given default of this debt in a risk neutral world. [3 points]
- Q13** Daixia is not so confident about Newcorp solvability and wants to insure against any loss if Newcorp fails to reimburse its debt. It wants to know what will be the price of a derivative that will protect it. [1 point]

Once you have answered the bank’s questions, your superior ask you to answer those of HineBev:

- Q14** What is the beta and the expected return of the equity? Finally what is the WACC of this company? [3 points]
- Q15** HineBev also wants to know how you manage to estimate the volatility of the assets of the new company (they say that usually this kind of data is difficult to obtain)? Explain that within the framework of structural pricing of risky debt. A solution is put forward by King and Matt (2003). What are the underlying hypotheses of King & Matt? [1 point]

N(x) & N(-x)=1-N(x)
 H. Pirotte - SBS/ULB - FinMetrics SA - Mai 2005

0.0	0.0000	0.5000	0.0100	0.0115	0.0200	0.0300	0.0400	0.0445	0.0500	0.0550	0.0620	0.0650	0.0700	0.0750	0.0800	0.0850	0.0900	0.0950
0.1	0.5398	0.5418	0.5438	0.5458	0.5478	0.5497	0.5517	0.5537	0.5557	0.5577	0.5597	0.5616	0.5636	0.5655	0.5675	0.5695	0.5714	0.5734
0.2	0.5793	0.5812	0.5832	0.5851	0.5871	0.5890	0.5910	0.5929	0.5948	0.5968	0.5987	0.6006	0.6026	0.6045	0.6064	0.6083	0.6103	0.6122
0.3	0.6179	0.6198	0.6217	0.6236	0.6255	0.6274	0.6293	0.6312	0.6331	0.6350	0.6369	0.6387	0.6406	0.6424	0.6443	0.6462	0.6480	0.6499
0.4	0.6554	0.6573	0.6591	0.6609	0.6628	0.6646	0.6664	0.6682	0.6700	0.6718	0.6736	0.6754	0.6772	0.6790	0.6808	0.6826	0.6844	0.6862
0.5	0.6915	0.6932	0.6950	0.6967	0.6985	0.7002	0.7019	0.7037	0.7054	0.7071	0.7088	0.7106	0.7123	0.7140	0.7157	0.7174	0.7190	0.7207
0.6	0.7257	0.7274	0.7291	0.7307	0.7324	0.7340	0.7357	0.7373	0.7389	0.7405	0.7422	0.7438	0.7454	0.7470	0.7486	0.7502	0.7517	0.7533
0.7	0.7580	0.7596	0.7611	0.7627	0.7642	0.7658	0.7673	0.7688	0.7704	0.7719	0.7734	0.7749	0.7764	0.7779	0.7794	0.7808	0.7823	0.7838
0.8	0.7881	0.7896	0.7910	0.7925	0.7939	0.7953	0.7967	0.7981	0.7995	0.8009	0.8023	0.8037	0.8051	0.8065	0.8078	0.8092	0.8106	0.8119
0.9	0.8159	0.8173	0.8186	0.8199	0.8212	0.8225	0.8238	0.8251	0.8264	0.8277	0.8289	0.8302	0.8315	0.8327	0.8340	0.8352	0.8365	0.8377
1.0	0.8413	0.8426	0.8438	0.8449	0.8461	0.8473	0.8485	0.8497	0.8508	0.8520	0.8531	0.8543	0.8554	0.8566	0.8577	0.8588	0.8599	0.8610
1.1	0.8643	0.8654	0.8665	0.8676	0.8686	0.8697	0.8708	0.8718	0.8729	0.8739	0.8749	0.8760	0.8770	0.8780	0.8790	0.8800	0.8810	0.8820
1.2	0.8849	0.8859	0.8869	0.8878	0.8888	0.8897	0.8907	0.8916	0.8925	0.8934	0.8944	0.8953	0.8962	0.8971	0.8980	0.8988	0.8997	0.9006
1.3	0.9032	0.9041	0.9049	0.9057	0.9066	0.9074	0.9082	0.9091	0.9099	0.9107	0.9115	0.9123	0.9131	0.9139	0.9147	0.9154	0.9162	0.9170
1.4	0.9192	0.9200	0.9207	0.9215	0.9222	0.9229	0.9236	0.9244	0.9251	0.9258	0.9265	0.9272	0.9279	0.9285	0.9292	0.9299	0.9306	0.9312
1.5	0.9332	0.9338	0.9345	0.9351	0.9357	0.9364	0.9370	0.9376	0.9382	0.9388	0.9394	0.9400	0.9406	0.9412	0.9418	0.9424	0.9430	0.9435
1.6	0.9452	0.9458	0.9463	0.9468	0.9474	0.9479	0.9484	0.9489	0.9495	0.9500	0.9505	0.9510	0.9515	0.9520	0.9525	0.9530	0.9535	0.9540
1.7	0.9554	0.9559	0.9564	0.9568	0.9573	0.9577	0.9582	0.9586	0.9591	0.9595	0.9599	0.9604	0.9608	0.9612	0.9616	0.9621	0.9625	0.9629
1.8	0.9641	0.9645	0.9649	0.9652	0.9656	0.9660	0.9664	0.9667	0.9671	0.9675	0.9678	0.9682	0.9686	0.9689	0.9693	0.9696	0.9699	0.9703
1.9	0.9713	0.9716	0.9719	0.9723	0.9726	0.9729	0.9732	0.9735	0.9738	0.9741	0.9744	0.9747	0.9750	0.9753	0.9756	0.9759	0.9761	0.9764
2.0	0.9772	0.9775	0.9778	0.9780	0.9783	0.9786	0.9788	0.9791	0.9793	0.9796	0.9801	0.9803	0.9805	0.9808	0.9810	0.9812	0.9815	0.9817
2.1	0.9821	0.9824	0.9826	0.9828	0.9830	0.9832	0.9834	0.9836	0.9838	0.9840	0.9842	0.9844	0.9846	0.9848	0.9850	0.9852	0.9854	0.9856
2.2	0.9861	0.9863	0.9864	0.9866	0.9868	0.9870	0.9871	0.9873	0.9875	0.9876	0.9878	0.9879	0.9881	0.9882	0.9883	0.9885	0.9887	0.9888
2.3	0.9893	0.9894	0.9896	0.9897	0.9898	0.9900	0.9901	0.9902	0.9904	0.9905	0.9906	0.9907	0.9909	0.9910	0.9911	0.9912	0.9913	0.9915
2.4	0.9916	0.9919	0.9920	0.9921	0.9922	0.9923	0.9925	0.9926	0.9927	0.9928	0.9929	0.9930	0.9931	0.9932	0.9933	0.9934	0.9935	0.9936
2.5	0.9938	0.9939	0.9940	0.9940	0.9941	0.9942	0.9943	0.9944	0.9945	0.9945	0.9946	0.9947	0.9948	0.9948	0.9949	0.9950	0.9951	0.9952
2.6	0.9953	0.9954	0.9955	0.9955	0.9956	0.9957	0.9957	0.9958	0.9959	0.9959	0.9960	0.9960	0.9961	0.9962	0.9962	0.9963	0.9964	0.9965
2.7	0.9965	0.9966	0.9967	0.9967	0.9968	0.9968	0.9968	0.9969	0.9969	0.9970	0.9970	0.9971	0.9971	0.9972	0.9972	0.9973	0.9974	0.9974
2.8	0.9974	0.9975	0.9975	0.9976	0.9976	0.9976	0.9977	0.9977	0.9977	0.9978	0.9978	0.9978	0.9979	0.9979	0.9979	0.9980	0.9980	0.9981
2.9	0.9981	0.9982	0.9982	0.9982	0.9982	0.9983	0.9983	0.9983	0.9984	0.9984	0.9984	0.9984	0.9985	0.9985	0.9985	0.9986	0.9986	0.9986
3.0	0.9987	0.9987	0.9987	0.9987	0.9987	0.9988	0.9988	0.9988	0.9988	0.9988	0.9989	0.9989	0.9989	0.9989	0.9989	0.9990	0.9990	0.9990
3.1	0.9990	0.9990	0.9991	0.9991	0.9991	0.9991	0.9991	0.9991	0.9992	0.9992	0.9992	0.9992	0.9992	0.9992	0.9993	0.9993	0.9993	0.9993
3.2	0.9993	0.9993	0.9993	0.9993	0.9994	0.9994	0.9994	0.9994	0.9994	0.9994	0.9994	0.9994	0.9994	0.9994	0.9995	0.9995	0.9995	0.9995
3.3	0.9995	0.9995	0.9995	0.9995	0.9996	0.9996	0.9996	0.9996	0.9996	0.9996	0.9996	0.9996	0.9996	0.9996	0.9996	0.9996	0.9997	0.9997
3.4	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9998	0.9998
3.5	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998
3.6	0.9998	0.9998	0.9998	0.9998	0.9998	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999
3.7	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999
3.8	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999
3.9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4.0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Call Prices with Black & Scholes Option Pricing

Price of a B&Sch call option where result=C/S

Cumulative Volatility: Sigma*SQRT(T)	Moneyness: $\frac{S e^{-qT}}{K e^{-rT}}$																							
	1.60	1.65	1.70	1.75	1.80	1.85	1.90	1.95	2.00	2.05	2.10	2.15	2.20	2.25	2.30	2.35	2.40	2.45	2.50	2.55	2.60	2.65	2.70	2.75
0.00	37.50%	39.39%	41.18%	42.86%	44.44%	45.95%	47.37%	48.72%	50.00%	51.22%	52.38%	53.49%	54.55%	55.56%	56.52%	57.45%	58.33%	59.18%	60.00%	60.78%	61.54%	62.26%	62.96%	63.64%
0.05	37.50%	39.39%	41.18%	42.86%	44.44%	45.95%	47.37%	48.72%	50.00%	51.22%	52.38%	53.49%	54.55%	55.56%	56.52%	57.45%	58.33%	59.18%	60.00%	60.78%	61.54%	62.26%	62.96%	63.64%
0.10	37.50%	39.39%	41.18%	42.86%	44.44%	45.95%	47.37%	48.72%	50.00%	51.22%	52.38%	53.49%	54.55%	55.56%	56.52%	57.45%	58.33%	59.18%	60.00%	60.78%	61.54%	62.26%	62.96%	63.64%
0.15	37.50%	39.40%	41.18%	42.86%	44.44%	45.95%	47.37%	48.72%	50.00%	51.22%	52.38%	53.49%	54.55%	55.56%	56.52%	57.45%	58.33%	59.18%	60.00%	60.78%	61.54%	62.26%	62.96%	63.64%
0.20	37.55%	39.42%	41.20%	42.87%	44.45%	45.95%	47.37%	48.72%	50.00%	51.22%	52.38%	53.49%	54.55%	55.56%	56.52%	57.45%	58.33%	59.18%	60.00%	60.78%	61.54%	62.26%	62.96%	63.64%
0.25	37.73%	39.56%	41.29%	42.94%	44.50%	45.99%	47.40%	48.74%	50.01%	51.23%	52.39%	53.49%	54.55%	55.56%	56.52%	57.45%	58.33%	59.18%	60.00%	60.78%	61.54%	62.26%	62.96%	63.64%
0.30	38.09%	39.85%	41.53%	43.13%	44.65%	46.11%	47.49%	48.81%	50.07%	51.28%	52.43%	53.52%	54.57%	55.58%	56.54%	57.46%	58.34%	59.19%	60.01%	60.79%	61.54%	62.27%	62.97%	63.64%
0.35	38.64%	40.32%	41.93%	43.47%	44.94%	46.35%	47.70%	48.99%	50.22%	51.40%	52.53%	53.61%	54.64%	55.64%	56.59%	57.50%	58.38%	59.22%	60.03%	60.81%	61.56%	62.28%	62.98%	63.65%
0.40	39.34%	40.94%	42.48%	43.95%	45.37%	46.72%	48.03%	49.27%	50.47%	51.62%	52.72%	53.77%	54.79%	55.76%	56.70%	57.60%	58.46%	59.29%	60.09%	60.86%	61.61%	62.32%	63.01%	63.68%
0.45	40.18%	41.70%	43.16%	44.57%	45.93%	47.23%	48.48%	49.68%	50.83%	51.94%	53.01%	54.04%	55.02%	55.97%	56.89%	57.77%	58.61%	59.43%	60.21%	60.97%	61.70%	62.41%	63.09%	63.75%
0.50	41.12%	42.56%	43.96%	45.30%	46.60%	47.84%	49.04%	50.20%	51.31%	52.38%	53.41%	54.40%	55.35%	56.27%	57.16%	58.02%	58.84%	59.64%	60.41%	61.15%	61.86%	62.56%	63.22%	63.87%
0.55	42.14%	43.52%	44.85%	46.13%	47.36%	48.55%	49.70%	50.81%	51.88%	52.90%	53.90%	54.85%	55.77%	56.66%	57.52%	58.35%	59.15%	59.92%	60.67%	61.39%	62.09%	62.77%	63.42%	64.05%
0.60	43.22%	44.53%	45.80%	47.03%	48.21%	49.35%	50.45%	51.51%	52.53%	53.52%	54.47%	55.39%	56.28%	57.14%	57.96%	58.76%	59.54%	60.29%	61.01%	61.71%	62.39%	63.05%	63.68%	64.30%
0.65	44.35%	45.61%	46.82%	47.99%	49.12%	50.21%	51.26%	52.28%	53.26%	54.20%	55.12%	56.00%	56.86%	57.68%	58.48%	59.25%	60.00%	60.72%	61.42%	62.10%	62.76%	63.39%	64.01%	64.61%
0.70	45.52%	46.72%	47.88%	49.00%	50.08%	51.12%	52.13%	53.10%	54.04%	54.95%	55.83%	56.68%	57.50%	58.29%	59.06%	59.80%	60.52%	61.22%	61.90%	62.55%	63.18%	63.80%	64.40%	64.98%
0.75	46.72%	47.87%	48.98%	50.05%	51.08%	52.08%	53.04%	53.98%	54.88%	55.75%	56.59%	57.41%	58.19%	58.96%	59.70%	60.41%	61.10%	61.78%	62.43%	63.06%	63.67%	64.26%	64.84%	65.40%
0.80	47.93%	49.03%	50.10%	51.12%	52.12%	53.07%	54.00%	54.89%	55.75%	56.59%	57.40%	58.18%	58.94%	59.67%	60.38%	61.07%	61.73%	62.38%	63.01%	63.62%	64.21%	64.78%	65.34%	65.88%
0.85	49.16%	50.22%	51.24%	52.22%	53.17%	54.09%	54.98%	55.84%	56.66%	57.47%	58.24%	58.99%	59.72%	60.42%	61.11%	61.77%	62.41%	63.03%	63.63%	64.22%	64.79%	65.34%	65.88%	66.40%
0.90	50.40%	51.42%	52.40%	53.34%	54.25%	55.13%	55.98%	56.81%	57.60%	58.37%	59.11%	59.84%	60.53%	61.21%	61.86%	62.50%	63.12%	63.71%	64.30%	64.86%	65.41%	65.94%	66.46%	66.96%
0.95	51.65%	52.62%	53.56%	54.47%	55.34%	56.19%	57.01%	57.79%	58.56%	59.30%	60.01%	60.70%	61.37%	62.02%	62.65%	63.26%	63.86%	64.43%	64.99%	65.53%	66.06%	66.57%	67.07%	67.55%
1.00	52.90%	53.83%	54.73%	55.60%	56.44%	57.26%	58.04%	58.80%	59.53%	60.24%	60.93%	61.59%	62.23%	62.86%	63.46%	64.05%	64.62%	65.17%	65.71%	66.23%	66.74%	67.23%	67.71%	68.18%
1.05	54.14%	55.04%	55.91%	56.74%	57.55%	58.33%	59.08%	59.81%	60.51%	61.20%	61.85%	62.49%	63.11%	63.71%	64.29%	64.86%	65.40%	65.93%	66.45%	66.95%	67.44%	67.91%	68.38%	68.82%
1.10	55.38%	56.25%	57.08%	57.88%	58.66%	59.41%	60.13%	60.83%	61.51%	62.16%	62.79%	63.41%	64.00%	64.58%	65.14%	65.68%	66.20%	66.71%	67.21%	67.69%	68.16%	68.62%	69.06%	69.49%
1.15	56.61%	57.45%	58.25%	59.02%	59.77%	60.49%	61.18%	61.85%	62.50%	63.13%	63.74%	64.33%	64.90%	65.45%	65.99%	66.51%	67.02%	67.51%	67.98%	68.45%	68.90%	69.34%	69.76%	70.18%
1.20	57.84%	58.64%	59.41%	60.15%	60.87%	61.56%	62.23%	62.87%	63.50%	64.10%	64.69%	65.25%	65.80%	66.33%	66.85%	67.35%	67.84%	68.31%	68.77%	69.21%	69.65%	70.07%	70.48%	70.88%
1.25	59.05%	59.82%	60.56%	61.28%	61.97%	62.63%	63.27%	63.90%	64.50%	65.08%	65.64%	66.18%	66.71%	67.22%	67.71%	68.20%	68.66%	69.12%	69.56%	69.99%	70.40%	70.81%	71.20%	71.59%
1.30	60.26%	61.00%	61.71%	62.40%	63.06%	63.70%	64.32%	64.91%	65.49%	66.05%	66.59%	67.11%	67.61%	68.11%	68.58%	69.04%	69.49%	69.93%	70.35%	70.76%	71.16%	71.55%	71.93%	72.30%
1.35	61.44%	62.16%	62.84%	63.50%	64.14%	64.76%	65.35%	65.92%	66.48%	67.01%	67.53%	68.03%	68.52%	68.99%	69.45%	69.89%	70.32%	70.74%	71.15%	71.54%	71.93%	72.30%	72.67%	73.02%
1.40	62.62%	63.30%	63.96%	64.60%	65.21%	65.80%	66.37%	66.92%	67.46%	67.97%	68.47%	68.95%	69.42%	69.87%	70.31%	70.74%	71.15%	71.56%	71.95%	72.33%	72.70%	73.06%	73.41%	73.75%
1.45	63.78%	64.44%	65.07%	65.68%	66.27%	66.84%	67.39%	67.92%	68.43%	68.92%	69.40%	69.87%	70.32%	70.75%	71.17%	71.58%	71.98%	72.37%	72.74%	73.11%	73.46%	73.81%	74.15%	74.47%
1.50	64.92%	65.55%	66.16%	66.75%	67.32%	67.86%	68.39%	68.90%	69.39%	69.87%	70.33%	70.77%	71.20%	71.62%	72.03%	72.42%	72.80%	73.17%	73.54%	73.89%	74.23%	74.56%	74.88%	75.20%
1.55	66.04%	66.65%	67.24%	67.81%	68.35%	68.87%	69.38%	69.87%	70.34%	70.80%	71.24%	71.67%	72.08%	72.48%	72.87%	73.25%	73.62%	73.98%	74.32%	74.66%	74.99%	75.31%	75.62%	75.92%
1.60	67.15%	67.74%	68.30%	68.84%	69.37%	69.87%	70.36%	70.83%	71.28%	71.72%	72.14%	72.55%	72.95%	73.34%	73.71%	74.08%	74.43%	74.77%	75.10%	75.43%	75.74%	76.05%	76.35%	76.64%
1.65	68.24%	68.80%	69.34%	69.87%	70.37%	70.85%	71.32%	71.77%	72.21%	72.63%	73.04%	73.43%	73.81%	74.18%	74.54%	74.89%	75.23%	75.56%	75.88%	76.19%	76.49%	76.78%	77.07%	77.35%
1.70	69.31%	69.85%	70.37%	70.87%	71.35%	71.82%	72.27%	72.70%	73.12%	73.52%	73.91%	74.29%	74.66%	75.02%	75.36%	75.70%	76.02%	76.34%	76.64%	76.94%	77.23%	77.51%	77.79%	78.05%
1.75	70.35%	70.87%	71.37%	71.86%	72.32%	72.77%	73.20%	73.61%	74.02%	74.40%	74.78%	75.14%	75.50%	75.84%	76.17%	76.49%	76.80%	77.10%	77.40%	77.68%	77.96%	78.23%	78.50%	78.75%
1.80	71.38%	71.88%	72.36%	72.82%	73.27%	73.70%	74.11%	74.51%	74.90%	75.27%	75.63%	75.98%	76.32%	76.64%	76.96%	77.27%	77.57%	77.86%	78.14%	78.42%	78.68%	78.94%	79.20%	79.44%
1.85	72.39%	72.87%	73.33%	73.77%	74.20%	74.61%	75.01%	75.39%	75.76%	76.12%	76.47%	76.80%	77.12%	77.44%	77.74%	78.04%	78.33%	78.60%	78.88%	79.14%	79.40%	79.64%	79.89%	80.12%
1.90	73.37%	73.83%	74.28%	74.70%	75.11%	75.51%	75.89%	76.26%	76.61%	76.95%	77.29%	77.61%	77.92%	78.22%	78.51%	78.80%	79.07%	79.34%	79.60%	79.85%	80.10%	80.33%	80.57%	80.79%
1.95	74.33%	74.78%	75.20%	75.61%	76.00%	76.38%	76.75%	77.10%	77.44%	77.77%	78.09%	78.40%	78.70%	78.99%	79.27%	79.54%	79.80%	80.06%	80.31%	80.55%	80.78%	81.01%	81.24%	81.45%
2.00	75.27%	75.70%	76.11%	76.50%	76.88%	77.24%	77.59%	77.93%	78.26%	78.57%	78.88%	79.17%	79.46%	79.74%	80.00%	80.26%	80.52%	80.76%	81.00%	81.23%	81.46%	81.68%	81.89%	82.10%

Put Prices with Black & Scholes Option Pricing

H. Pirotte - SBS/ULB - FinMetrics SA - Juin 2006

Price of a B&Sch call option where result=P/S

Cumulative Volatility Sigma*SQRT(T)	Moneyness: Se^{-qT} / Ke^{-rT}																							
	1.60	1.65	1.70	1.75	1.80	1.85	1.90	1.95	2.00	2.05	2.10	2.15	2.20	2.25	2.30	2.35	2.40	2.45	2.50	2.55	2.60	2.65	2.70	2.75
0.00	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
0.05	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
0.10	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
0.15	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
0.20	0.05%	0.03%	0.02%	0.01%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
0.25	0.23%	0.16%	0.12%	0.08%	0.06%	0.04%	0.03%	0.02%	0.01%	0.01%	0.01%	0.01%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
0.30	0.59%	0.46%	0.35%	0.27%	0.21%	0.16%	0.13%	0.10%	0.07%	0.06%	0.04%	0.03%	0.03%	0.02%	0.02%	0.01%	0.01%	0.01%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%
0.35	1.14%	0.92%	0.75%	0.61%	0.50%	0.40%	0.33%	0.27%	0.22%	0.18%	0.15%	0.12%	0.10%	0.08%	0.07%	0.05%	0.04%	0.04%	0.03%	0.02%	0.02%	0.01%	0.01%	0.01%
0.40	1.84%	1.55%	1.30%	1.10%	0.92%	0.78%	0.66%	0.56%	0.47%	0.40%	0.34%	0.29%	0.24%	0.21%	0.18%	0.15%	0.13%	0.11%	0.09%	0.08%	0.07%	0.06%	0.05%	0.04%
0.45	2.68%	2.30%	1.99%	1.71%	1.48%	1.28%	1.11%	0.96%	0.83%	0.73%	0.63%	0.55%	0.48%	0.42%	0.37%	0.32%	0.28%	0.24%	0.21%	0.19%	0.17%	0.15%	0.13%	0.11%
0.50	3.62%	3.17%	2.78%	2.45%	2.15%	1.90%	1.67%	1.48%	1.31%	1.16%	1.03%	0.91%	0.81%	0.72%	0.64%	0.57%	0.51%	0.45%	0.41%	0.36%	0.33%	0.29%	0.26%	0.23%
0.55	4.64%	4.12%	3.67%	3.27%	2.92%	2.61%	2.33%	2.09%	1.88%	1.69%	1.52%	1.36%	1.23%	1.11%	1.00%	0.90%	0.82%	0.74%	0.67%	0.61%	0.55%	0.50%	0.46%	0.42%
0.60	5.72%	5.14%	4.63%	4.17%	3.76%	3.40%	3.08%	2.79%	2.53%	2.30%	2.09%	1.90%	1.73%	1.58%	1.44%	1.32%	1.21%	1.10%	1.01%	0.93%	0.85%	0.78%	0.72%	0.66%
0.65	6.85%	6.21%	5.64%	5.13%	4.67%	4.26%	3.89%	3.56%	3.26%	2.98%	2.74%	2.51%	2.31%	2.13%	1.96%	1.80%	1.67%	1.54%	1.42%	1.31%	1.22%	1.13%	1.05%	0.97%
0.70	8.02%	7.33%	6.70%	6.14%	5.63%	5.18%	4.76%	4.38%	4.04%	3.73%	3.45%	3.19%	2.95%	2.74%	2.54%	2.36%	2.19%	2.04%	1.90%	1.77%	1.65%	1.54%	1.43%	1.34%
0.75	9.22%	8.47%	7.80%	7.19%	6.64%	6.13%	5.68%	5.26%	4.88%	4.53%	4.21%	3.92%	3.65%	3.40%	3.17%	2.96%	2.77%	2.59%	2.43%	2.27%	2.13%	2.00%	1.88%	1.77%
0.80	10.43%	9.64%	8.92%	8.27%	7.67%	7.13%	6.63%	6.17%	5.75%	5.37%	5.02%	4.69%	4.39%	4.11%	3.86%	3.62%	3.40%	3.20%	3.01%	2.83%	2.67%	2.52%	2.37%	2.24%
0.85	11.66%	10.83%	10.06%	9.37%	8.73%	8.15%	7.61%	7.12%	6.66%	6.25%	5.86%	5.50%	5.17%	4.87%	4.58%	4.32%	4.07%	3.85%	3.63%	3.43%	3.25%	3.08%	2.91%	2.76%
0.90	12.90%	12.02%	11.22%	10.48%	9.81%	9.19%	8.62%	8.09%	7.60%	7.15%	6.73%	6.35%	5.99%	5.65%	5.34%	5.05%	4.78%	4.53%	4.30%	4.07%	3.87%	3.67%	3.49%	3.32%
0.95	14.15%	13.23%	12.39%	11.61%	10.90%	10.24%	9.64%	9.08%	8.56%	8.08%	7.63%	7.21%	6.83%	6.47%	6.13%	5.82%	5.52%	5.25%	4.99%	4.75%	4.52%	4.31%	4.11%	3.92%
1.00	15.40%	14.44%	13.56%	12.75%	12.00%	11.31%	10.67%	10.08%	9.53%	9.02%	8.54%	8.10%	7.69%	7.30%	6.94%	6.60%	6.29%	5.99%	5.71%	5.45%	5.20%	4.97%	4.75%	4.54%
1.05	16.64%	15.65%	14.73%	13.89%	13.11%	12.38%	11.71%	11.09%	10.51%	9.98%	9.47%	9.00%	8.57%	8.16%	7.77%	7.41%	7.07%	6.75%	6.45%	6.17%	5.90%	5.65%	5.41%	5.19%
1.10	17.88%	16.85%	15.90%	15.03%	14.21%	13.46%	12.76%	12.11%	11.51%	10.94%	10.41%	9.92%	9.46%	9.02%	8.61%	8.23%	7.87%	7.53%	7.21%	6.91%	6.62%	6.35%	6.10%	5.86%
1.15	19.11%	18.05%	17.07%	16.16%	15.32%	14.54%	13.81%	13.13%	12.50%	11.91%	11.36%	10.84%	10.35%	9.90%	9.47%	9.06%	8.68%	8.32%	7.98%	7.66%	7.36%	7.07%	6.80%	6.54%
1.20	20.34%	19.25%	18.23%	17.30%	16.43%	15.62%	14.86%	14.16%	13.50%	12.88%	12.31%	11.77%	11.26%	10.78%	10.33%	9.90%	9.50%	9.12%	8.77%	8.43%	8.11%	7.80%	7.51%	7.24%
1.25	21.55%	20.43%	19.39%	18.42%	17.52%	16.69%	15.91%	15.18%	14.50%	13.86%	13.26%	12.69%	12.16%	11.66%	11.19%	10.75%	10.33%	9.93%	9.56%	9.20%	8.86%	8.54%	8.24%	7.95%
1.30	22.76%	21.60%	20.53%	19.54%	18.61%	17.75%	16.95%	16.19%	15.49%	14.83%	14.20%	13.62%	13.07%	12.55%	12.06%	11.60%	11.16%	10.74%	10.35%	9.98%	9.63%	9.29%	8.97%	8.67%
1.35	23.94%	22.76%	21.67%	20.65%	19.70%	18.81%	17.98%	17.20%	16.48%	15.79%	15.15%	14.54%	13.97%	13.44%	12.93%	12.45%	11.99%	11.56%	11.15%	10.76%	10.39%	10.04%	9.71%	9.39%
1.40	25.12%	23.91%	22.79%	21.74%	20.77%	19.86%	19.00%	18.21%	17.46%	16.75%	16.09%	15.46%	14.87%	14.32%	13.79%	13.29%	12.82%	12.37%	11.95%	11.54%	11.16%	10.79%	10.44%	10.11%
1.45	26.28%	25.04%	23.90%	22.83%	21.83%	20.89%	20.02%	19.20%	18.43%	17.70%	17.02%	16.38%	15.77%	15.19%	14.65%	14.14%	13.65%	13.18%	12.74%	12.32%	11.92%	11.54%	11.18%	10.84%
1.50	27.42%	26.16%	24.99%	23.89%	22.87%	21.92%	21.02%	20.18%	19.39%	18.65%	17.95%	17.28%	16.66%	16.07%	15.51%	14.97%	14.47%	13.99%	13.54%	13.10%	12.69%	12.30%	11.92%	11.56%
1.55	28.54%	27.26%	26.06%	24.95%	23.91%	22.93%	22.01%	21.15%	20.34%	19.58%	18.86%	18.18%	17.54%	16.93%	16.35%	15.81%	15.29%	14.79%	14.32%	13.88%	13.45%	13.04%	12.65%	12.28%
1.60	29.65%	28.34%	27.12%	25.99%	24.92%	23.93%	22.99%	22.11%	21.28%	20.50%	19.76%	19.07%	18.41%	17.78%	17.19%	16.63%	16.10%	15.59%	15.10%	14.64%	14.20%	13.78%	13.38%	13.00%
1.65	30.74%	29.41%	28.17%	27.01%	25.92%	24.91%	23.95%	23.05%	22.21%	21.41%	20.65%	19.94%	19.27%	18.63%	18.02%	17.44%	16.90%	16.37%	15.88%	15.40%	14.95%	14.52%	14.11%	13.71%
1.70	31.81%	30.45%	29.19%	28.01%	26.91%	25.87%	24.90%	23.98%	23.12%	22.30%	21.53%	20.80%	20.11%	19.46%	18.84%	18.25%	17.69%	17.15%	16.64%	16.16%	15.69%	15.25%	14.82%	14.42%
1.75	32.85%	31.48%	30.20%	29.00%	27.88%	26.82%	25.83%	24.90%	24.02%	23.18%	22.40%	21.65%	20.95%	20.28%	19.65%	19.04%	18.47%	17.92%	17.40%	16.90%	16.42%	15.97%	15.53%	15.12%
1.80	33.88%	32.49%	31.18%	29.97%	28.82%	27.75%	26.74%	25.79%	24.90%	24.05%	23.25%	22.49%	21.77%	21.09%	20.44%	19.82%	19.24%	18.68%	18.14%	17.63%	17.15%	16.68%	16.23%	15.81%
1.85	34.89%	33.47%	32.15%	30.92%	29.76%	28.67%	27.64%	26.67%	25.76%	24.90%	24.08%	23.31%	22.58%	21.88%	21.22%	20.59%	19.99%	19.42%	18.88%	18.35%	17.86%	17.38%	16.92%	16.49%
1.90	35.87%	34.44%	33.10%	31.84%	30.67%	29.56%	28.52%	27.54%	26.61%	25.73%	24.90%	24.12%	23.37%	22.66%	21.99%	21.35%	20.74%	20.15%	19.60%	19.07%	18.56%	18.07%	17.60%	17.16%
1.95	36.83%	35.38%	34.03%	32.75%	31.56%	30.44%	29.38%	28.38%	27.44%	26.55%	25.71%	24.91%	24.15%	23.43%	22.74%	22.09%	21.47%	20.87%	20.31%	19.76%	19.24%	18.75%	18.27%	17.82%
2.00	37.77%	36.31%	34.93%	33.64%	32.43%	31.30%	30.22%	29.21%	28.26%	27.35%	26.50%	25.68%	24.91%	24.18%	23.48%	22.82%	22.18%	21.58%	21.00%	20.45%	19.92%	19.41%	18.93%	18.46%