WESTERN SYDNEY UNIVERSITY

FINAL EXAM – AUTUMN/1H SESSION 2017

School of Business

Complete your details in this section when instructed by the Exam Supervisor at the start of the exam. *You should also complete your details on any answer booklets provided.*	
STUDENT SURNAME:	
STUDENT FIRST NAME:	
STUDENT ID:	

EXAM INSTRUCTIONS *Read all the information below and follow any instructions carefully before proceeding.* *This exam is printed on <u>both sides</u> of the paper – ensure you answer all the questions.* *You may begin writing when instructed by the Exam Supervisor at the start of the exam.* *Clearly indicate which question you are answering on any Examination Answer Booklets used.*			
UNIT NAME:	Derivatives		
UNIT NUMBER:	200079		
NUMBER OF QUESTIONS:	Part A has 5 questions, Part B has 5 questions.		
VALUE OF QUESTIONS:	Part A questions are worth 2 marks each. Part B questions are worth 8 marks each. This totals to 50 marks.		
ANSWERING QUESTIONS:	Part A: Answer multiple choice questions on the scan sheet provided. Part B: Answer all other questions on the exam paper itself.		
LECTURER/UNIT COORDINATOR:	Keith Woodward		
TIME ALLOWED:	2 hours	TOTAL PAGES:	13

RESOURCES ALLOWED *Only the resources listed below are allowed in this exam.*
Any calculator which has the primary function of a calculator is allowed. For example, calculators on mobile phones or similar electronic devices are not allowed.

<u>DO NOT TAKE THIS PAPER FROM THE EXAM ROOM</u>

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Part A

Note that the next 3 questions have the same answer options, but different questions.

Question 1: Which of the following derivative instruments has a **non**-zero value when it's first agreed to?

(a) Futures contract.

(b) Forward contract.

(c) Interest rate swap.

*(d) Call option.

Question 2: Which of the following statements about fixed-for-floating interest rate swaps is **NOT** correct?

(a) No price is paid at the start when the swap is first agreed to.

(b) No face value is paid at the end when the swap matures.

(c) Payments throughout the life of the swap are netted out so only one party will pay their counterparty at each time.

*(d) The 'swap rate' is the swap's current floating benchmark rate that is specified in the contract, such as LIBOR.

(e) They're traded OTC.

Question 3: Which of the following statements about the Black-Scholes-Merton option pricing equation is **NOT** correct?

(a) The return 'r' must be a continuously compounded return.

(b) If the option maturity time period is measured in years, then the return 'r' and the standard deviation of returns must also be per year.

*(c) The return 'r' is the future expected return of the underlying asset in a world where investors are risk-averse.

(d) The standard deviation is the future expected volatility of the underlying asset.

(e) The model assumes that the underlying asset price is log-normally distributed.

Question 4: Which of the following statements about American-style options is **NOT** correct?

American-style:

(a) Options are always worth more than or equal to equivalent European-style options.

(b) Call options on dividend-paying stocks should sometimes be exercised just before the dividend.

(c) Put options on dividend-paying stocks should sometimes be exercised just after the dividend.

(d) Call options should be exercised now if the intrinsic option value (S-K) is greater than the expected present value of the option's future payoffs.

*(e) Put options should be exercised now if the intrinsic option value (K-S) is less than the expected present value of the option's future payoffs.

Question 5: Which class of derivatives market trader is **NOT** principally focused on 'buying low and selling high'?

*(a) Hedgers.

(b) Speculators.

(c) Arbitrageurs.

(d) Market makers.

(e) Insider traders.

Part B

Question 1 (total of 8 marks): A stock index is expected to pay a continuously compounded dividend yield **5**% pa for the foreseeable future. The index is currently at **5,800** points, the continuously compounded total required return is **8**% p.a and its standard deviation of returns is **20**% p.a.. An investor has just taken a long position in a **one** year **put** option contract on the index with a strike price of **5,700**. Compute the **put** option price in index points using the Black-Scholes model.

Question 1a (3 marks): Calculate d_1.

*d1= 0.336958714

Question 1b (1 mark): Calculate d_2.

*d2= 0.136958714

Question 1c (1 mark): Calculate the put option delta using the tables in the back of this exam paper.

*-N(-d1)= -0.368074012

Question 1d (1 mark): Calculate the risk-neutral probability that the put option ends up being 'in the money' at maturity. You can use the tables in the back of this exam paper.

*N(-d2)= 0.445531715

Question 1e (2 marks): Calculate the put option price in index points.

*p0 = 313.5699526

Question 2 (total of 8 marks): The below table summarises the borrowing costs confronting two companies.

Borrowing Costs		
	Fixed Rate	Floating Rate
Firm A	4%	6-month LIBOR + 0.2%
Firm B	3%	6-month LIBOR + 0.5%

Question 2a (6 marks): Suppose Firm A wants to borrow at a fixed rate and Firm B wishes to borrow floating.

Design an intermediated swap that provides a bank with a spread of **15** basis points p.a., and gives the remaining swap benefits **to firm B only**.

Use a clearly labelled diagram to summarise the terms of the arrangement.

*Firm A has an absolute advantage in the floating rate market.

Firm B has an absolute advantage in the fixed rate market.

Comparative advantages reflect absolute advantages in this case.

So Firm A should issue a floating rate bond and Firm B should issue a fixed rate bond.

The total benefit available to all 3 parties including the bank is the difference of differences which is:

TotalBenefitToABAndBank = |(4-3) - (L+0.2-(L+0.5))| = |1 - - 0.3| = 1.3%

Subtract the bank's spread to find the benefit to the banks:

TotalBenefitToB = 1.3% - 0.15% = 1.15%. Firm B gets all of this benefit.

A pays 4-0.2+0=3.8% B receives 3-0.5+1.15=3.65%

A pays L+0.2% **Firm A** **Bank** **Firm B** B pays 3%

A receives L B pays L

Question 2b (2 marks): If the LIBOR rate unexpectedly rises after Firm A and B sign the swap contract, who will gain from the swap contracts (not from the physical bonds)? Firm A or B? Circle the correct answer:

***Firm A,** **Firm B,** **both** **or neither.**

Question 3 (total of 8 marks): Consider the below screen shot of the details of an American call option on BHP.

BHPN89 - $25.00 CALL OPTION EXPIRING 25/05/2017

Underlying Security Details: BHP BLT FPO [BHP] (ASX:BHP) As of: 6/04/2017 3:15:04 PM

Last Price	Today's Change	Bid	Offer	Day High	Day Low	Volume
$24.610	-$0.140 (-.57%)	$24.610	$24.620	$24.720	$24.470	5,170,752

Today's Last Price	**0.9**	**Bid**	0.740	**Theo Price**	0.856
Today's Change	**0.005 (0.56%)**	**Offer**	0.865	**Days To Expiry**	50
Open	0	**Previous Close**	0.9	**Shares per Contract**	100
Volume	0	**Open Interest**	2,032	**Today's Range**	0 - 0

As at 6/04/2017 3:15:05 PM

Buyers			Sellers	
Quantity	Price	#	Price	Quantity
400	0.740	1	0.865	400
200	0.735	2	0.870	200
400	0.725	3	0.875	200
0	0.000	4	0.880	200
0	0.000	5	0.000	0

Question 3a (1 marks): What is the bid-ask spread on these **options** (not the underlying stock)?

*$0.125 (=0.865 – 0.74)

Question 3b (1 marks): What is your best estimate of the 'true price' of these call options?

*$0.8025 (=(0.865 + 0.74)/2)

Question 3c (1 marks): What is the best price that you could **buy** one call option contract when placing a market order? Be aware that one call option contract is on 100 shares and prices are listed on a per-share basis rather than a per contract basis.

*$0.865 on a per share basis or $86.50 since one call option contract is on 100 shares.

Question 3d (1 marks): How much money could you **sell 600** call options for? (Note that in this question you are selling, in the previous question, you are buying).

*$44,300 (=((400*0.74)+(200*0.735))*100)

Question 3e (1 marks): What would be the **implicit cost** of **selling** these 600 call options, given your 'true price' answered above?

$3,850 (=((400(0.8025-0.74)) + 200*(0.8025-0.735))*100)

Question 3f (1 marks): Is this call option 'in-the-money' or 'out-of-the-money'?

*Out of the money since S < K, 24.610 < 25.

Question 3g (1 marks): What's more liquid, the stock or the option? Explain your answer.

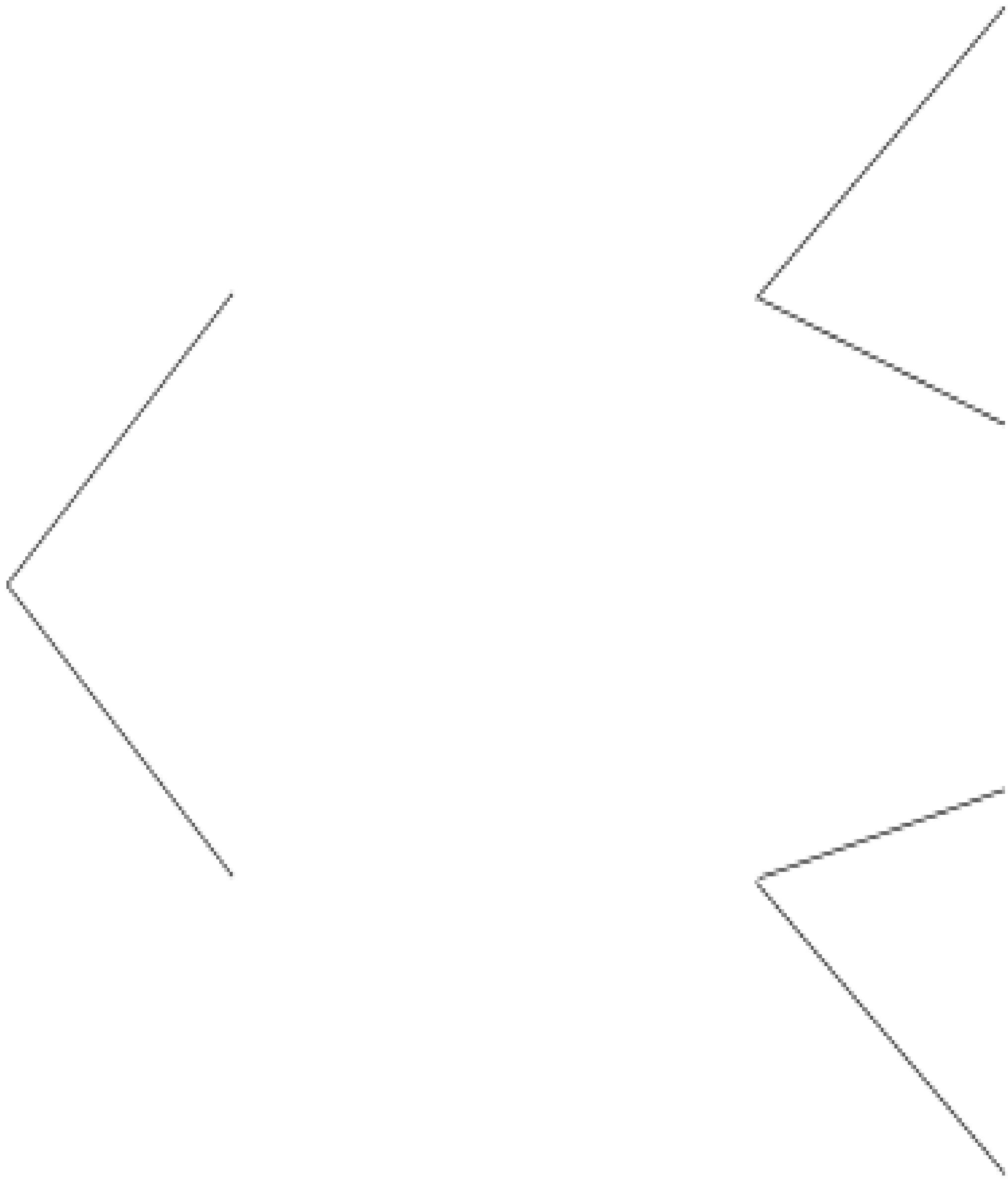
*The stock is more liquid due to its higher trading volume and smaller bid-ask spread compared to the call option.

Question 3h (1 marks): If the stock price were to remain at exactly the same level between now and the option expiry in Dec 2017, would you expect the call option price to rise, fall, or stay the same?

*Fall. This is because as the time shortens, the volatility until maturity will also fall so the stock price varies less and has a lower chance of growing larger than the strike price, which means there's a lower chance that the call option ends up being in the money. Since call options have everything to gain but little to lose from more volatility, the call option is worth less when volatility per time or the time remaining until maturity falls. This is sometimes called the 'time decay' or 'Theta' of an option.

Question 4 (total of 8 marks): Consider a **one** year **American** call option with a strike price of $**9**, written on a dividend paying stock currently trading at $**10**. The dividend is paid annually and the next dividend is expected to be $**1**, paid in **6** months. The risk-free interest rate is **5**% p.a. continuously compounded and the standard deviation of the stock's returns is **20**% pa.

Calculate the option price now (t=0) using either the no-arbitrage approach or the risk-neutral approach with a two-step binomial tree with 6 months per step. Remember that the option is American so it can be exercised before maturity. There are formulas on the formula sheet to help. You may wish to use the binomial tree below to work out the answer.



European (1) or American (-1)	-1	Stock				
Call (1) or put (-1)	1	t=0	t=0.5yr just before div	t=0.5yr just after div		t=1yr option payoff at maturity
S0	10				12.11705	3.117055
T	1		11.5191	10.5191		
sd pa	0.2				9.131877	0.131877
t	0.5	10				
Dt, one off paid at t only and not at end	1				8.84809	0
K	9		8.681234	7.681234		
r	0.05				6.66826	0
u	1.15191					
d	0.868123	Option				
prob	0.553908	t=0	t=0.5yr just before div	t=0.5yr just after div		t=1yr option payoff at maturity
			lapse	1.74131		3.117055
			intrinsic value before div	2.519099		
			optimum	2.519099		0.131877
	Option price now	1.360899				
			lapse	0		0
			intrinsic value before div	-0.31877		
			optimum	0		0

Question 5 (total of 8 marks): Suppose a stock currently trades at $**60**. The stock's semi-annual dividend is expected to be $**4**, paid in **5** months from now. Note that the dividend is paid after the future expires. Assume a **7**% continuously compounded risk-free rate.

Question 5a (3 marks): Calculate the futures price of a **3**-month **futures** contract on this stock, as implied by the above information.

F_0.25 = S_0*exp(r*3/12)

=60*exp(0.07*3/12)

=61.05924133

Question 5b (5 marks): If the fair futures price that you calculated above suddenly changed to $**59** but all else was unchanged and there was no news about the company, then explain how you could conduct a risk-free arbitrage. Assume that the future is mis-priced. You're best able to show the steps using an arbitrage table. Hint: Construct the arbitrage table by having some position in the physical mispriced future above and an offsetting position in a synthetic future. The synthetic future can be constructed using stocks and bonds.

*Long the physical future since it's underpriced. Short the synthetic future (=short stock, and long bond (borrow)) to balance out the risk.

Viewing the below amounts as investments (not cash flows) at time zero, then all positive investments are payments by us now which are buy (long) transactions and all negative investments are receipts to us now which are sell (short) transactions:

$$V_{0SFsynthetic} = -\left(S_0 - \frac{K_T}{e^{r.T}}\right)$$

ShortSyntheticFuture = ShortStock + LongBond

To find the amounts of these assets that we need to long and short to make a risk free zero capital arbitrage, we'll use an arbitrage table. Note that this arbitrage table shows cash flows, not investments:

Action	**t=0**	**t=3mth**
Long physical future	0	ST-59
Short stock	60	ST
Long bond (lend now)	-57.9764819 (=-59/exp(3/12*0.07)) (Step 3)	59 (Step 2)
Total	2.023518096 (Step 4)	0 (Step 1)

Formulas

$$r_{continuouslycompounded} = ln(1 + r_{discrete})$$

$$P_0 = \frac{P_t}{e^{t.r_{continuouslycompounded}}}$$

$$P_0 = \frac{P_t}{(1 + r_{discrete})^t}$$

$$r_{discrete} = e^{r_{continuouslycompounded}} - 1$$

$$h \quad = \rho_{S,F} \cdot \frac{\sigma_S}{\sigma_F}$$

$$N_{notailing} = h \quad . \frac{Q_S}{Q_F}$$

$$N_{tailing} = h \quad . \frac{V_S}{V_F}$$

$$F = S_0 . e^{r.T}$$

$$f_{0,long} = S_0 - K . e^{-r.T}$$

$$f_{long} = -f_{short}$$

$$p = \frac{e^{rt} - d}{u - d}$$

$$u = e^{\sigma\sqrt{t}}$$

$$d = \frac{1}{u} = e^{-\sigma\sqrt{t}}$$

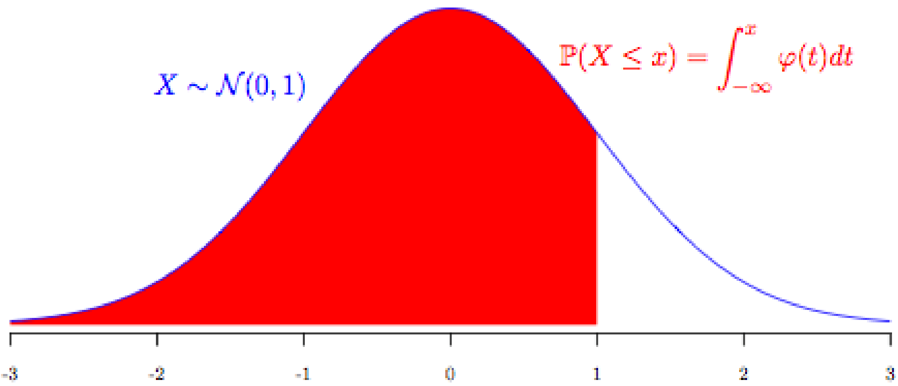
$$c_0 + K . e^{-r.T} = p_0 + S_0$$

$$c_0 = S_0 . N(d_1) - K . e^{-r.T} . N(d_2)$$

$$p_0 = -S_0 . N(-d_1) + K . e^{-r.T} . N(-d_2)$$

$$d_1 = \frac{ln\left(\frac{S_0}{K}\right) + \left(r + \frac{\sigma^2}{2}\right) . T}{\sigma . T^{0.5}}$$

$$d_2 = d_1 - \sigma . T^{0.5} = \frac{ln\left(\frac{S_0}{K}\right) + \left(r - \frac{\sigma^2}{2}\right) . T}{\sigma . T^{0.5}}$$



	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.5000	0.5040	0.5080	0.5120	0.5160	0.5199	0.5239	0.5279	0.5319	0.5359
0.1	0.5398	0.5438	0.5478	0.5517	0.5557	0.5596	0.5636	0.5675	0.5714	0.5753
0.2	0.5793	0.5832	0.5871	0.5910	0.5948	0.5987	0.6026	0.6064	0.6103	0.6141
0.3	0.6179	0.6217	0.6255	0.6293	0.6331	0.6368	0.6406	0.6443	0.6480	0.6517
0.4	0.6554	0.6591	0.6628	0.6664	0.6700	0.6736	0.6772	0.6808	0.6844	0.6879
0.5	0.6915	0.6950	0.6985	0.7019	0.7054	0.7088	0.7123	0.7157	0.7190	0.7224
0.6	0.7257	0.7291	0.7324	0.7357	0.7389	0.7422	0.7454	0.7486	0.7517	0.7549
0.7	0.7580	0.7611	0.7642	0.7673	0.7704	0.7734	0.7764	0.7794	0.7823	0.7852
0.8	0.7881	0.7910	0.7939	0.7967	0.7995	0.8023	0.8051	0.8078	0.8106	0.8133
0.9	0.8159	0.8186	0.8212	0.8238	0.8264	0.8289	0.8315	0.8340	0.8365	0.8389
1.0	0.8413	0.8438	0.8461	0.8485	0.8508	0.8531	0.8554	0.8577	0.8599	0.8621
1.1	0.8643	0.8665	0.8686	0.8708	0.8729	0.8749	0.8770	0.8790	0.8810	0.8830
1.2	0.8849	0.8869	0.8888	0.8907	0.8925	0.8944	0.8962	0.8980	0.8997	0.9015
1.3	0.9032	0.9049	0.9066	0.9082	0.9099	0.9115	0.9131	0.9147	0.9162	0.9177
1.4	0.9192	0.9207	0.9222	0.9236	0.9251	0.9265	0.9279	0.9292	0.9306	0.9319
1.5	0.9332	0.9345	0.9357	0.9370	0.9382	0.9394	0.9406	0.9418	0.9429	0.9441
1.6	0.9452	0.9463	0.9474	0.9484	0.9495	0.9505	0.9515	0.9525	0.9535	0.9545
1.7	0.9554	0.9564	0.9573	0.9582	0.9591	0.9599	0.9608	0.9616	0.9625	0.9633
1.8	0.9641	0.9649	0.9656	0.9664	0.9671	0.9678	0.9686	0.9693	0.9699	0.9706
1.9	0.9713	0.9719	0.9726	0.9732	0.9738	0.9744	0.9750	0.9756	0.9761	0.9767
2.0	0.9772	0.9778	0.9783	0.9788	0.9793	0.9798	0.9803	0.9808	0.9812	0.9817
2.1	0.9821	0.9826	0.9830	0.9834	0.9838	0.9842	0.9846	0.9850	0.9854	0.9857
2.2	0.9861	0.9864	0.9868	0.9871	0.9875	0.9878	0.9881	0.9884	0.9887	0.9890
2.3	0.9893	0.9896	0.9898	0.9901	0.9904	0.9906	0.9909	0.9911	0.9913	0.9916
2.4	0.9918	0.9920	0.9922	0.9925	0.9927	0.9929	0.9931	0.9932	0.9934	0.9936
2.5	0.9938	0.9940	0.9941	0.9943	0.9945	0.9946	0.9948	0.9949	0.9951	0.9952
2.6	0.9953	0.9955	0.9956	0.9957	0.9959	0.9960	0.9961	0.9962	0.9963	0.9964
2.7	0.9965	0.9966	0.9967	0.9968	0.9969	0.9970	0.9971	0.9972	0.9973	0.9974
2.8	0.9974	0.9975	0.9976	0.9977	0.9977	0.9978	0.9979	0.9979	0.9980	0.9981
2.9	0.9981	0.9982	0.9982	0.9983	0.9984	0.9984	0.9985	0.9985	0.9986	0.9986
3.0	0.9987	0.9987	0.9987	0.9988	0.9988	0.9989	0.9989	0.9989	0.9990	0.9990

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