

**ADM 2304**  
**APPLICATIONS OF STATISTICAL METHODS IN BUSINESS**

October 18, 2008  
9:00 - 11:00 AM

NAME (please print): \_\_\_\_\_

Student Number: \_\_\_\_\_

SECTION REGISTERED (Circle one):      A                      B

Time allowed: Two (2) hours after start of exam.

Length of Exam: 5 pages, plus a 2-page Minitab supplement (please return).

Please show all your work and explain your answers briefly where required.

You are encouraged to use the Minitab output as much as possible. However, it should be noted that not all Minitab procedures given are appropriate for the situations described.

You are permitted to have a calculator and 1 sheet (8.5 x 11" paper) of notes.

Statistical tables (normal, t and F) are provided separately (please keep).

Marks:       $\frac{\quad}{9}$       +       $\frac{\quad}{11}$       +       $\frac{\quad}{10}$       +       $\frac{\quad}{5}$       =       $\frac{\quad}{35}$

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The School of Management does not condone academic fraud, an act by a student that may result in a false academic evaluation of that student or of another student. Without limiting the generality of this definition, academic fraud occurs when a student commits any of the following offences: plagiarism or cheating of any kind, use of books, notes, mathematical tables, dictionaries or other study aid unless an explicit written note to the contrary appears on the exam, to have in his/her possession cameras, radios (radios with head sets), tape recorders, pagers, cell phones, or any other communication device which has not been previously authorized in writing.

I have read the text on academic integrity and I pledge not to have committed or attempted to commit academic fraud in this examination.

Signed: \_\_\_\_\_

**1. [ 9 marks ]**

The Green Party won 4.5% of the popular vote in the 2006 general election. A recent poll taken on October 12, 2008 by Harris-Decima reported that 9% of a sample of 1000 respondents support the Green Party.

- (a) Test at the .05 level of significance whether the Harris-Decima results support the contention that the Green Party has garnered more popular support since the last election.

[4]

- (b) What is the probability-value (p-value) of the sample result?

[1]

- (c) Calculate a 95% 1-sided confidence interval for the current level of support for the Green Party.

[2]

- (d) Suppose you want to estimate the current level of support using a 95% 2-sided confidence interval. What sample size would be required to obtain a margin of error of plus or minus 1%?

[2]

**2. [ 11 marks ]**

A random sample of 60 families in Ottawa-Vanier has an average income of \$92,000 and a standard deviation of \$31,000, while a random sample of 40 families in Ottawa-Orleans has an average income of \$108,000 and a standard deviation of \$23,000.

- (a) Test at the .01 level of significance whether these data constitute sufficient evidence to show a difference in average income in the respective populations of Ottawa-Vanier and Ottawa-Orleans.

[4]

- (b) What is the p-value for the result in (a)?

[2]

- (c) Calculate a 95% confidence interval for the difference in the average incomes between the two populations.

[3]

- (d) What key assumptions must be satisfied to justify the calculations above? Do you think these are warranted? Explain briefly.

[2]

**3. [ 10 marks ]**

The Canada Revenue Agency (CRA) implemented a paperwork simplification program (PSP) which it hopes will decrease the number of inquiries from taxpayers to its telephone response system. A random sample of fourteen offices were asked to collect data on number of inquiries the year before the PSP was implemented, and then to repeat the process the year after the PSP was implemented.

The program evaluation officer would like to show that PSP has cut down on the average number of calls. The MINITAB output can be found in Appendix A.

- (a) Does the experimental design call for an independent samples test or a paired sample test. Explain briefly.

[1]

- (b) Now look at the graphs. Explain whether a parametric t-test or a non-parametric test is more appropriate, with reference to specific graphs. Identify the most appropriate test.

[2]

- (c) Using the test identified above, determine at the .05 level of significance whether the PSP has been effective at reducing the average (mean or median) number of calls.

[4]

- (d) If you completed a parametric test above, now perform a non-parametric test. If you completed a non-parametric test above, now perform a parametric test.

[3]

4. [ 5 marks ]

The following problem is from Siegel, **Practical Business Statistics, 2nd Ed.**

In the period following the crash of October 19, 1987, the market was generally believed to be in a volatile state. You can measure the extent of this volatility by using the standard deviation of the daily changes in the Dow Jones Index:

Standard Deviation	Time Period
<b>.0117</b>	August 1 to October 9 (10 weeks)
.0836	October 12 (1 week before) to October 26 (1 week after)
<b>.0209</b>	October 27 to December 31, 1987 (9 weeks)

- (a) Test to see if there is a difference in the underlying volatility of the market between the first and third periods above (excluding the two weeks around the crash itself). Clearly state the level of significance you are permitted to use given the statistical tables and **assume that there were 5 observations for each week.**

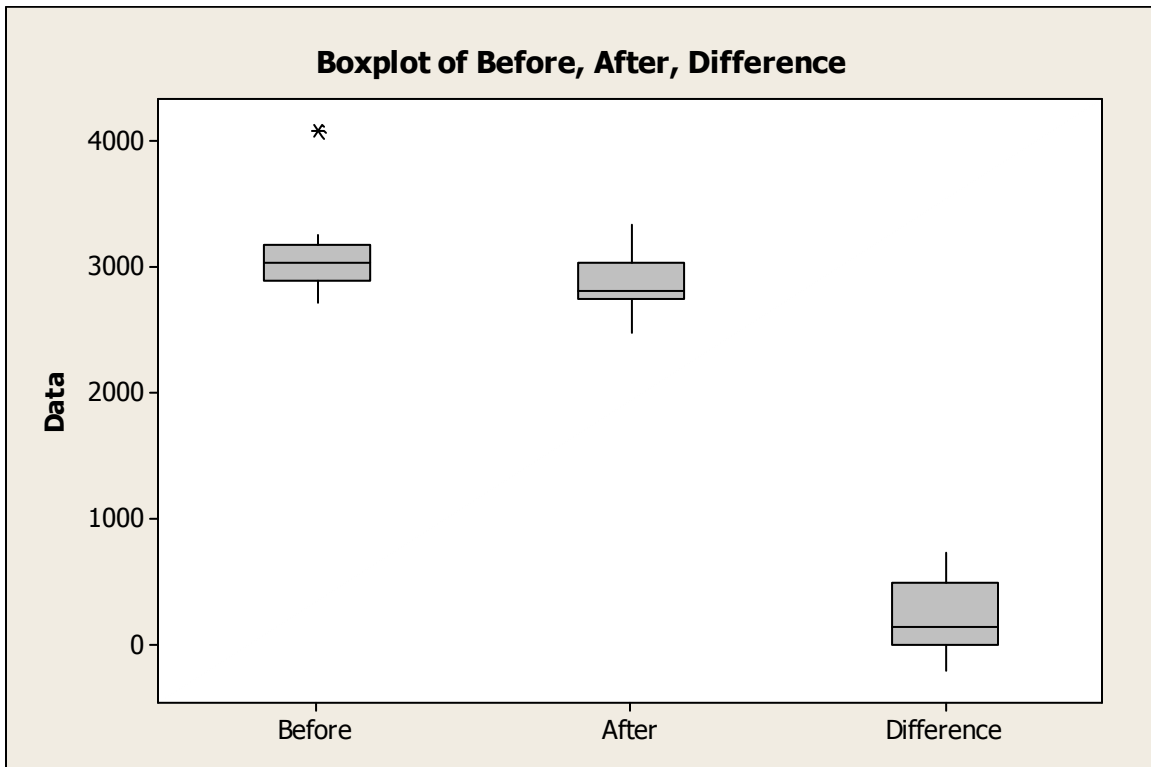
[4]

- (b) What key assumptions are required to justify the test performed? Be brief but precise.

[1]

## Appendix A.

Before	After	Difference
3253	2770	483
3069	3037	32
2708	2907	-199
2826	2785	41
3208	2598	610
2899	3029	-130
4072	3338	734
2964	2788	176
2987	2821	166
2983	2468	515
2828	2692	136
3090	2762	328
3101	2968	133
3154	3216	-62



## Two-Sample T-Test and CI: Before, After

Two-sample T for Before vs After

				SE
	N	Mean	StDev	Mean
Before	14	3082	324	87
After	14	2870	233	62

Difference = mu (Before) - mu (After)

Estimate for difference: 211.643

95% lower bound for difference: 28.628

T-Test of difference = 0 (vs >): T-Value = 1.98 P-Value = 0.030 DF = 23

## Paired T-Test and CI: Before, After

Paired T for Before - After

	N	Mean	StDev	SE Mean
Before	14	3081.57	324.29	86.67
After	14	2869.93	233.40	62.38
Difference	14	211.643	283.877	75.869

95% lower bound for mean difference: 77.283

T-Test of mean difference = 0 (vs > 0): T-Value = 2.79 P-Value = 0.008

## Wilcoxon Signed Rank Test: Difference

Test of median = 0.000000 versus median > 0.000000

	N	for	Wilcoxon		Estimated
	N	Test	Statistic	P	Median
Difference	14	14	89.0	0.012	184.5

## Mann-Whitney Test and CI: Before, After

	N	Median
Before	14	3028.0
After	14	2804.5

Point estimate for ETA1-ETA2 is 184.5

95.4 Percent CI for ETA1-ETA2 is (6.9,358.1)

W = 248.0

Test of ETA1 = ETA2 vs ETA1 > ETA2 is significant at 0.0204

## Standard Normal Distribution

z	P( 0 ≤ Z ≤ z )									
	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.0000	0.0040	0.0080	0.0120	0.0160	0.0199	0.0239	0.0279	0.0319	0.0359
0.1	0.0398	0.0438	0.0478	0.0517	0.0557	0.0596	0.0636	0.0675	0.0714	0.0753
0.2	0.0793	0.0832	0.0871	0.0910	0.0948	0.0987	0.1026	0.1064	0.1103	0.1141
0.3	0.1179	0.1217	0.1255	0.1293	0.1331	0.1368	0.1406	0.1443	0.1480	0.1517
0.4	0.1554	0.1591	0.1628	0.1664	0.1700	0.1736	0.1772	0.1808	0.1844	0.1879
0.5	0.1915	0.1950	0.1985	0.2019	0.2054	0.2088	0.2123	0.2157	0.2190	0.2224
0.6	0.2257	0.2291	0.2324	0.2357	0.2389	0.2422	0.2454	0.2486	0.2517	0.2549
0.7	0.2580	0.2611	0.2642	0.2673	0.2704	0.2734	0.2764	0.2794	0.2823	0.2852
0.8	0.2881	0.2910	0.2939	0.2967	0.2995	0.3023	0.3051	0.3078	0.3106	0.3133
0.9	0.3159	0.3186	0.3212	0.3238	0.3264	0.3289	0.3315	0.3340	0.3365	0.3389
1.0	0.3413	0.3438	0.3461	0.3485	0.3508	0.3531	0.3554	0.3577	0.3599	0.3621
1.1	0.3643	0.3665	0.3686	0.3708	0.3729	0.3749	0.3770	0.3790	0.3810	0.3830
1.2	0.3849	0.3869	0.3888	0.3907	0.3925	0.3944	0.3962	0.3980	0.3997	0.4015
1.3	0.4032	0.4049	0.4066	0.4082	0.4099	0.4115	0.4131	0.4147	0.4162	0.4177
1.4	0.4192	0.4207	0.4222	0.4236	0.4251	0.4265	0.4279	0.4292	0.4306	0.4319
1.5	0.4332	0.4345	0.4357	0.4370	0.4382	0.4394	0.4406	0.4418	0.4429	0.4441
1.6	0.4452	0.4463	0.4474	0.4484	0.4495	0.4505	0.4515	0.4525	0.4535	0.4545
1.7	0.4554	0.4564	0.4573	0.4582	0.4591	0.4599	0.4608	0.4616	0.4625	0.4633
1.8	0.4641	0.4649	0.4656	0.4664	0.4671	0.4678	0.4686	0.4693	0.4699	0.4706
1.9	0.4713	0.4719	0.4726	0.4732	0.4738	0.4744	0.4750	0.4756	0.4761	0.4767
2.0	0.4772	0.4778	0.4783	0.4788	0.4793	0.4798	0.4803	0.4808	0.4812	0.4817
2.1	0.4821	0.4826	0.4830	0.4834	0.4838	0.4842	0.4846	0.4850	0.4854	0.4857
2.2	0.4861	0.4864	0.4868	0.4871	0.4875	0.4878	0.4881	0.4884	0.4887	0.4890
2.3	0.4893	0.4896	0.4898	0.4901	0.4904	0.4906	0.4909	0.4911	0.4913	0.4916
2.4	0.4918	0.4920	0.4922	0.4925	0.4927	0.4929	0.4931	0.4932	0.4934	0.4936
2.5	0.4938	0.4940	0.4941	0.4943	0.4945	0.4946	0.4948	0.4949	0.4951	0.4952
2.6	0.4953	0.4955	0.4956	0.4957	0.4959	0.4960	0.4961	0.4962	0.4963	0.4964
2.7	0.4965	0.4966	0.4967	0.4968	0.4969	0.4970	0.4971	0.4972	0.4973	0.4974
2.8	0.4974	0.4975	0.4976	0.4977	0.4977	0.4978	0.4979	0.4979	0.4980	0.4981
2.9	0.4981	0.4982	0.4982	0.4983	0.4984	0.4984	0.4985	0.4985	0.4986	0.4986
3.0	0.4987	0.4987	0.4987	0.4988	0.4988	0.4989	0.4989	0.4989	0.4990	0.4990
3.1	0.4990	0.4991	0.4991	0.4991	0.4992	0.4992	0.4992	0.4992	0.4993	0.4993
3.2	0.4993	0.4993	0.4994	0.4994	0.4994	0.4994	0.4994	0.4995	0.4995	0.4995
3.3	0.4995	0.4995	0.4995	0.4996	0.4996	0.4996	0.4996	0.4996	0.4996	0.4997
3.4	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4998
3.5	0.4998	0.4998	0.4998	0.4998	0.4998	0.4998	0.4998	0.4998	0.4998	0.4998
3.6	0.4998	0.4998	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999
3.7	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999
3.8	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999
3.9	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000

## Student's t distribution

d.f.	Probabilities to the right										
	0.250	0.200	0.150	0.100	0.075	0.050	0.030	0.025	0.010	0.005	0.001
1	1.00	1.38	1.96	3.08	4.17	6.31	10.58	12.71	31.82	63.66	318.31
2	0.82	1.06	1.39	1.89	2.28	2.92	3.90	4.30	6.96	9.92	22.33
3	0.76	0.98	1.25	1.64	1.92	2.35	2.95	3.18	4.54	5.84	10.21
4	0.74	0.94	1.19	1.53	1.78	2.13	2.60	2.78	3.75	4.60	7.17
5	0.73	0.92	1.16	1.48	1.70	2.02	2.42	2.57	3.36	4.03	5.89
6	0.72	0.91	1.13	1.44	1.65	1.94	2.31	2.45	3.14	3.71	5.21
7	0.71	0.90	1.12	1.41	1.62	1.89	2.24	2.36	3.00	3.50	4.79
8	0.71	0.89	1.11	1.40	1.59	1.86	2.19	2.31	2.90	3.36	4.50
9	0.70	0.88	1.10	1.38	1.57	1.83	2.15	2.26	2.82	3.25	4.30
10	0.70	0.88	1.09	1.37	1.56	1.81	2.12	2.23	2.76	3.17	4.14
11	0.70	0.88	1.09	1.36	1.55	1.80	2.10	2.20	2.72	3.11	4.02
12	0.70	0.87	1.08	1.36	1.54	1.78	2.08	2.18	2.68	3.05	3.93
13	0.69	0.87	1.08	1.35	1.53	1.77	2.06	2.16	2.65	3.01	3.85
14	0.69	0.87	1.08	1.35	1.52	1.76	2.05	2.14	2.62	2.98	3.79
15	0.69	0.87	1.07	1.34	1.52	1.75	2.03	2.13	2.60	2.95	3.73
16	0.69	0.86	1.07	1.34	1.51	1.75	2.02	2.12	2.58	2.92	3.69
17	0.69	0.86	1.07	1.33	1.51	1.74	2.02	2.11	2.57	2.90	3.65
18	0.69	0.86	1.07	1.33	1.50	1.73	2.01	2.10	2.55	2.88	3.61
19	0.69	0.86	1.07	1.33	1.50	1.73	2.00	2.09	2.54	2.86	3.58
20	0.69	0.86	1.06	1.33	1.50	1.72	1.99	2.09	2.53	2.85	3.55
21	0.69	0.86	1.06	1.32	1.49	1.72	1.99	2.08	2.52	2.83	3.53
22	0.69	0.86	1.06	1.32	1.49	1.72	1.98	2.07	2.51	2.82	3.50
23	0.69	0.86	1.06	1.32	1.49	1.71	1.98	2.07	2.50	2.81	3.48
24	0.68	0.86	1.06	1.32	1.49	1.71	1.97	2.06	2.49	2.80	3.47
25	0.68	0.86	1.06	1.32	1.49	1.71	1.97	2.06	2.49	2.79	3.45
26	0.68	0.86	1.06	1.31	1.48	1.71	1.97	2.06	2.48	2.78	3.43
27	0.68	0.86	1.06	1.31	1.48	1.70	1.96	2.05	2.47	2.77	3.42
28	0.68	0.85	1.06	1.31	1.48	1.70	1.96	2.05	2.47	2.76	3.41
29	0.68	0.85	1.06	1.31	1.48	1.70	1.96	2.05	2.46	2.76	3.40

		<b>F-Table for alpha = 0.050</b>									
Den d.f.	Num d.f.										
	31	32	33	33	34	35	40	45	50	200	
30	1.83	1.83	1.82	1.82	1.82	1.81	1.79	1.77	1.76	1.66	
31	1.82	1.82	1.81	1.81	1.81	1.80	1.78	1.76	1.75	1.65	
32	1.81	1.80	1.80	1.80	1.79	1.79	1.77	1.75	1.74	1.63	
33	1.80	1.79	1.79	1.79	1.78	1.78	1.76	1.74	1.72	1.62	
35	1.78	1.77	1.77	1.77	1.76	1.76	1.74	1.72	1.70	1.60	
40	1.74	1.73	1.73	1.73	1.72	1.72	1.69	1.67	1.66	1.55	
45	1.71	1.70	1.69	1.69	1.69	1.68	1.66	1.64	1.63	1.51	
50	1.68	1.67	1.67	1.67	1.66	1.66	1.63	1.61	1.60	1.48	
100	1.57	1.56	1.55	1.55	1.55	1.54	1.52	1.49	1.48	1.34	
200	1.51	1.50	1.49	1.49	1.49	1.48	1.46	1.43	1.41	1.26	