The Hong Kong Polytechnic University

MM604 Statistical Analysis for Management Research

Assignment 1

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1. American manufacturers are concerned with the increase of Japanese produced television sets in the US retail markets after an import quota was lifted. Inventory levels of imported television sets are compared one month before and one month after the lifting of the import quota to determine if there is an significant increase. A paired t-test can be used to compare the before and after inventory levels. The hypothesis to be tested are:

   H_0: Average inventory levels of imported TVs are the same before and after the lifting of the import quota.

   H_1: Average inventory levels of imported TVs are NOT the same before and after the lifting of the import quota.

T-Test

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	AFTER	149.75	8	57.375	20.285
	BEFORE	137.38	8	55.926	19.773

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	AFTER & BEFORE	8	.946	.000

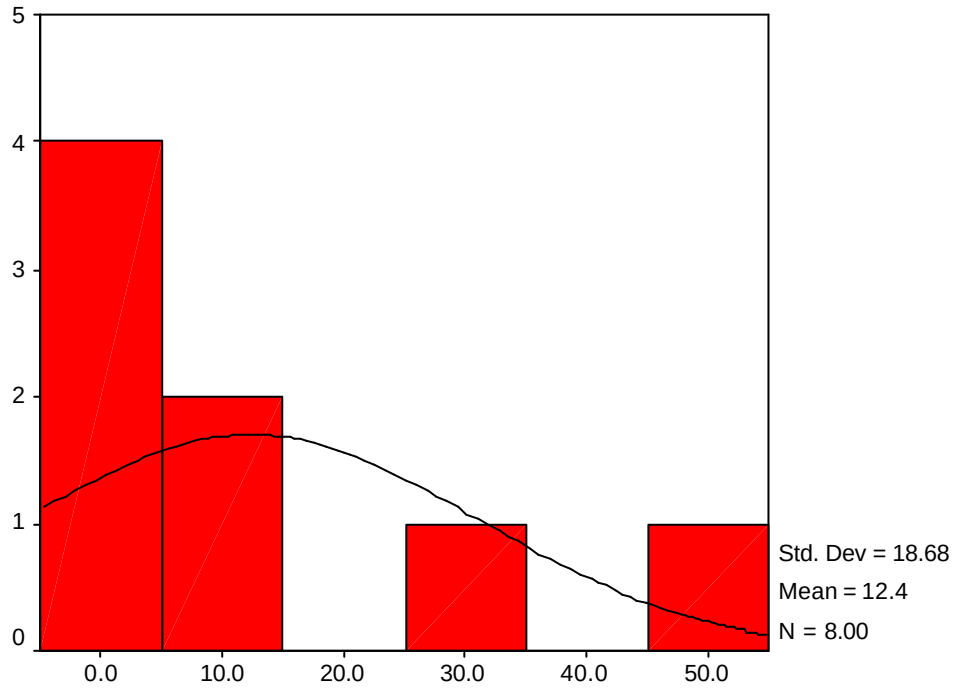
Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	AFTER - BEFORE	12.38	18.677	6.603	-3.24	27.99	1.874	7	.103

The two-tailed paired t-test indicates that the difference between the before and after inventory level is significant at the 10.3% level. Since the study is only concerned with an increase in the level of inventory, a one-tailed paired t-test should be used. To adjust for this, the significant level is halved to 5.15%.

Based on the actual significant level of 5.15% and the test level of 5%, we cannot reject the null hypothesis that the mean level of inventory is the same before and after the lifting of the import quota. Hence we conclude that the level of inventory of imported television sets has not statistically increased significantly at a 5% level after the lifting of the import quota.

The histogram below graphs the distribution of the change in inventory level. It appears that the difference might not come from a normal distribution. In addition, the sample size of 8 is small. As a result, a non-parametric test (Wilcoxon Test) is used to confirm the earlier paired t-test results.



The non-parametric Wilcoxon Signed Ranks test results below indicate that the difference in inventory level is significant at 6.8% level. As before, since we are interested in the increase of inventory level only, the actual significant level of 6.8% should be halved to 3.4% to determine the significant level for a one-tailed test. Based

on this result, we can reject the null hypothesis that the mean level of inventory is the same before and after the lifting of the import quota. As a result, we conclude based on the non-parametric Wilcoxon test that the level of inventory of Japanese produced television sets has statistically increased significantly at a 5% level after the lifting of the import quota.

Wilcoxon Signed Ranks Test

Ranks

		N	Mean Rank	Sum of Ranks
BEFORE - AFTER	Negative Ranks	6(a)	5.17	31.00
	Positive Ranks	2(b)	2.50	5.00
	Ties	0(c)		
	Total	8		

a BEFORE < AFTER
b BEFORE > AFTER
c BEFORE = AFTER

Test Statistics(b)

	BEFORE - AFTER
Z	-1.825(a)
Asymp. Sig. (2-tailed)	.068

a Based on positive ranks.
b Wilcoxon Signed Ranks Test

Since we obtained contradictory conclusions using parametric and non-parametric tests, a firm statistical conclusion cannot be drawn. To rectify this situation, an increase in sample size should be obtained and both the tests should be performed again using the expanded sample set. In additions to the small sample size, there are several other shortcomings of the current data set which are described below. In order to effectively present their view points, the American manufacturers should address these issues before further pressing their case for a reincarnation of the import quota.

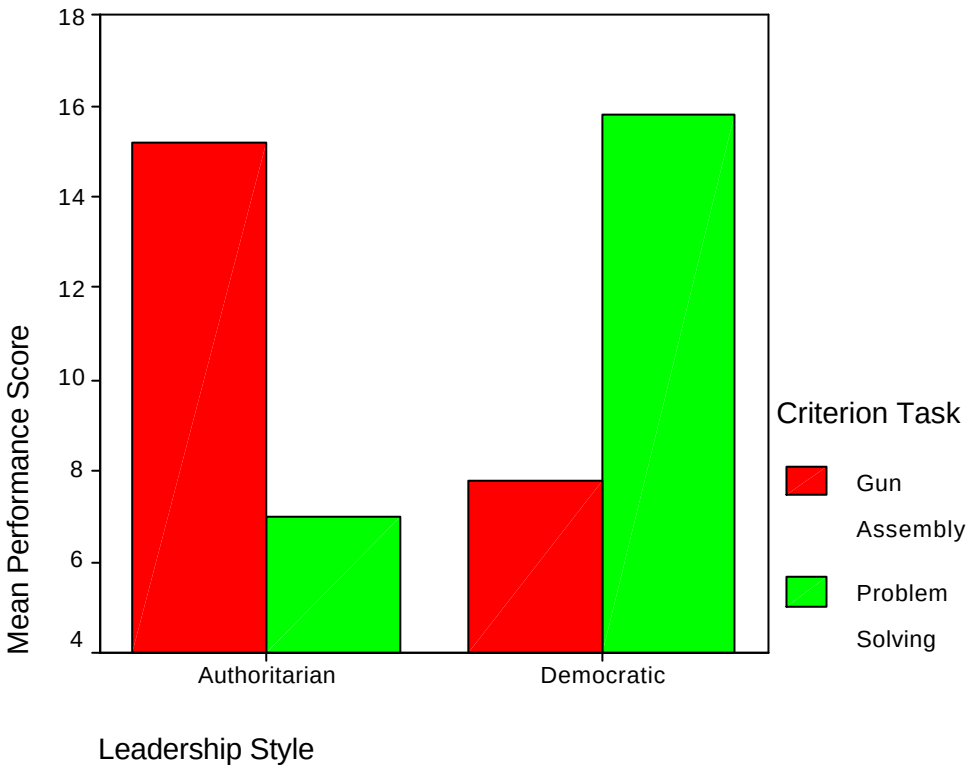
Caution should be used in the interpretation of the results of this statistical analysis as the data set has several shortcomings. First, the change in inventory level between the two time periods could be due to reasons other than then lifting of the quota, meaning that the removal of the import quota might not be the cause of the inventory increase. The retailers might increase the general level of all their inventories due to seasonal sales reasons; as such, the number of US made television sets will experience the same increase. Second, the statistical analysis only provides information on the relationship between the pair of numbers. The analysis does not imply causal relationship. Hence, the results of the statistical analysis does not provide evidence that the lifting of the quota causes the increase in inventory of imported TV sets. Third, the data does not take into account the alternative choice of non-Japanese made television sets. To make their case more persuasive, the American manufacturers should use the ratio of Japanese made to American made television sets as the basis of the study for the increase. Fourth, the use of 8 retail outlets might be too small to be representative of the population. In particular, the origins of television sets being sold are affected by local customer profiles and demographics. Fifth, increase in inventory of Japanese produced television set does not mean that they are dumping. The increase might be due to higher demand for their products because of higher quality. Sixth, dumping is defined as selling below cost. Since cost factors are not included in this study, it would be inappropriate to draw any conclusion on cost or dumping based on the results on this analysis. Seventh, the survey collected was based on imported television sets which could include television sets made in Korea, Germany or other non-Japanese countries.

2. In this study of leadership style and task performance, there are two independent variables, leadership style and nature of task. It is hypothesized that task performance are affected by both the style of the leadership and the nature of the task. Ten groups of soldiers were used and task performance scores are obtained for two styles of leadership and two types of task.

H_0: Task performance is not affected by the leadership style and the nature of task.

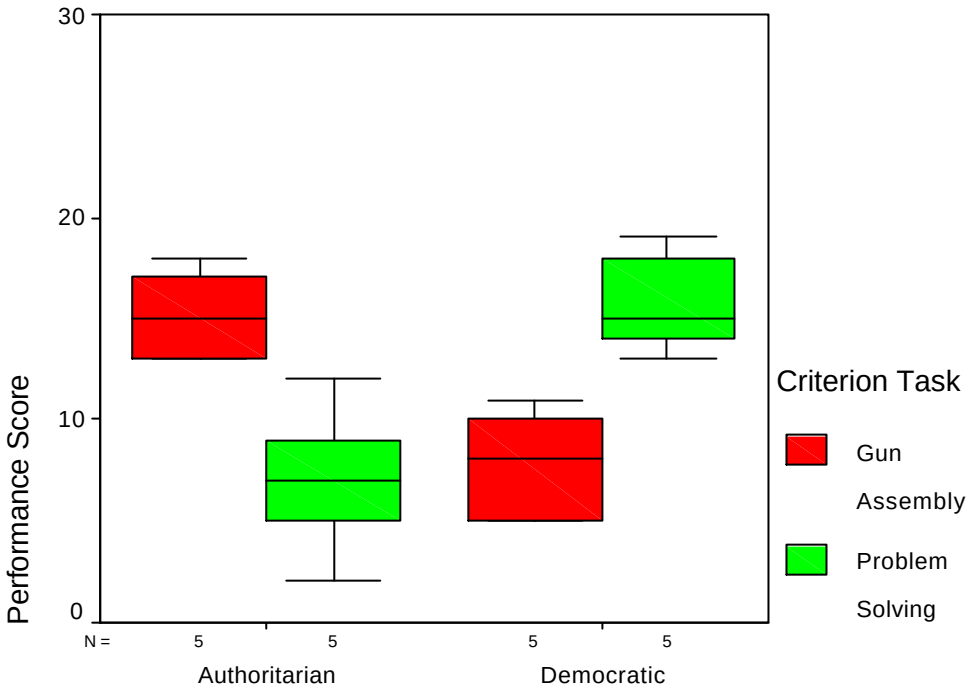
H_1: Task performance is affected by the leadership style and the nature of task.

The bar chart below summarizes the finding.



A preliminary inspection of the bar graph indicates that there appears to be a difference in performance dependent on the style of leadership and nature of task. In particular, it appears that authoritarian leadership style is better suited for structured tasks like gun assembly; on the other hand, democratic leadership style is better suited for group problem solving tasks.

The box-and-whiskers plot below indicates that the distribution of the task performance does not overlap and there is difference in task performance between the leadership style and nature of task.



The hypothesis to be tested is that leadership style does not affect the task performance of structured task (i.e. gun assembly) and group problem (i.e. problem solving), meaning that the performance scores are not significantly different between the two types of tasks. Since the performance scores are marks awarded, we are trying to compare the equality of the population means using leadership style and nature of task as classification criteria. As such, two-way ANOVA is used for the analysis.

Univariate Analysis of Variance

Descriptive Statistics

Dependent Variable: SCORE

CRIT	LEAD	Mean	Std. Deviation	N
1.00	1.00	15.2000	2.28035	5
	2.00	7.8000	2.77489	5
	Total	11.5000	4.57651	10
2.00	1.00	7.0000	3.80789	5
	2.00	15.8000	2.58844	5
	Total	11.4000	5.56177	10
Total	1.00	11.1000	5.23768	10
	2.00	11.8000	4.91709	10
	Total	11.4500	4.95745	20

Levene's Test of Equality of Error Variances(a)

Dependent Variable: SCORE

F	df1	df2	Sig.
.400	3	16	.755

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.
a Design: Intercept+CRIT+LEAD+CRIT * LEAD

Tests of Between-Subjects Effects

Dependent Variable: SCORE

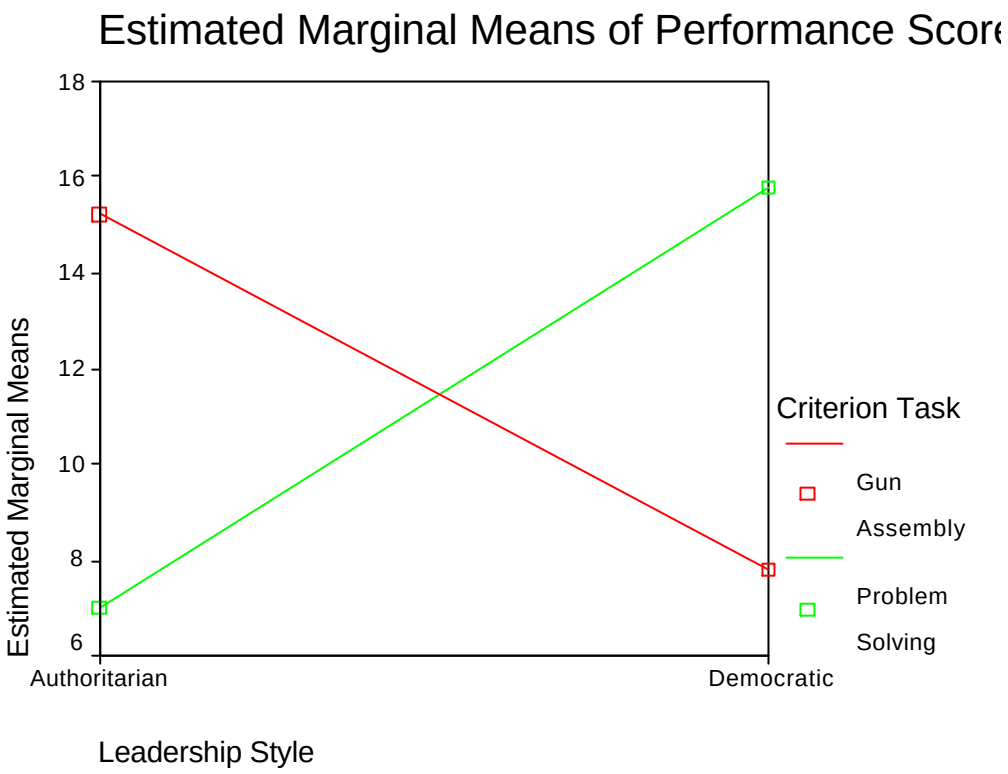
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	330.550(a)	3	110.183	12.925	.000
Intercept	2622.050	1	2622.050	307.572	.000
CRIT	.050	1	.050	.006	.940
LEAD	2.450	1	2.450	.287	.599
CRIT * LEAD	328.050	1	328.050	38.481	.000
Error	136.400	16	8.525		
Total	3089.000	20			
Corrected Total	466.950	19			

a R Squared = .708 (Adjusted R Squared = .653)

The Levene's test of equality of error variances cannot reject the null hypothesis that the error variance is equal across the four groups of observations.

The result of the two-way ANOVA rejects the null hypothesis that the means of the groups are the same. The "Corrected Model" is significant at the 0.015% level and the interaction between leadership style and nature of task ("CRIT*LEAD") is significant at 0.001% level. The "Corrected Model" result rejects the null hypothesis that the

population means are the same across the four groups of observations. The "CRIT*LEAD" result indicates that there are significant interaction between these two classifications. The plot below also confirms the indication that there are interaction between the leadership style and the nature of task.



Based on the analysis of the results of the study, we found that leadership style does affect the task performance dependent on the nature of the task. That is, for structured tasks like gun assembly, an authoritarian leadership style will produce better performance; for group problem solving, a democratic leadership style will produce better performance.

3. ABC Shoes Company

ABC Shoe Company wants to measure sales potential against four independent variables. These four independent variables are (a) percentage of US footwear sales (X_1), (b) number of accounts services (X_2), (c) percentage of US personal income (X_3), and (d) percentage of non-white population (X_4).

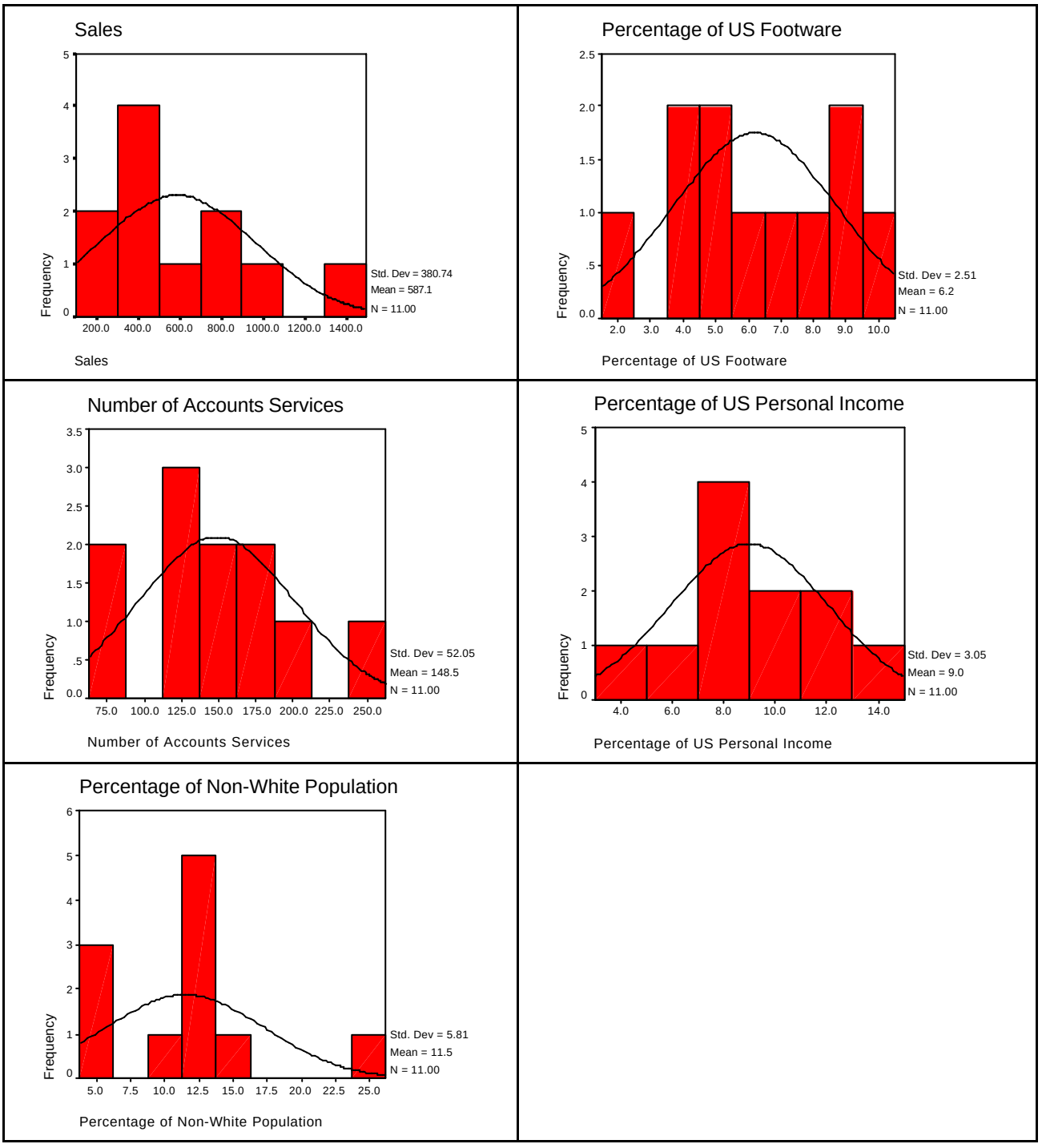
The basic information on the territory sales (Y, in thousand dollars) and the four independent variables are provided below. Based on the review of the histograms, it appears that all the variables have distributions that are approximately normal. Scatterplot matrix is prepared to confirm linear relationships between dependent and independent variables. Independent variable X_4 was transformed by taking the natural log as there appears to be a non-linear relationship with the dependent variable prior to the transformation.

Description of Variables.

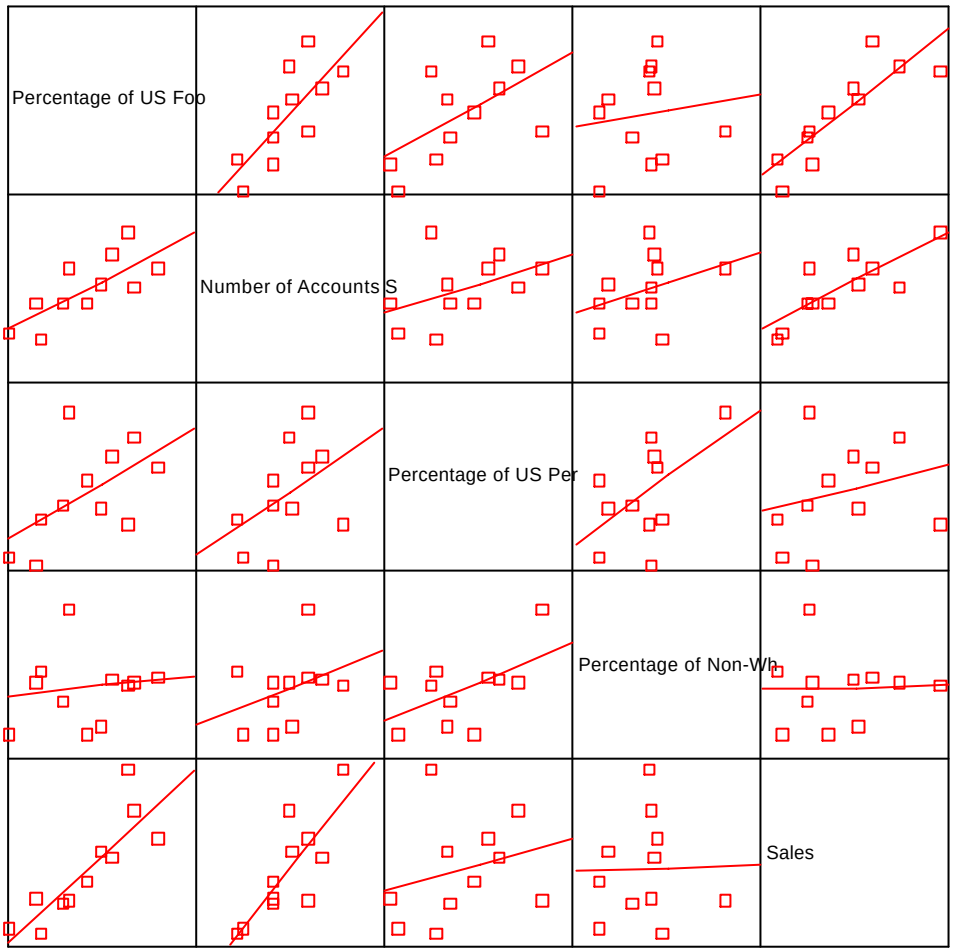
		Y Sales	X1 Percentage of US Footware	X2 Number of Accounts Services	X3 Percentage of US Personal Income	X4 Percentage of Non-White Population
N	Valid	11	11	11	11	11
	Missing	0	0	0	0	0
Mean		587.091	6.209	148.545	8.991	11.482
Median		498.000	6.300	153.000	8.200	12.600
Mode		119.0(a)	2.1(a)	125.0	4.4(a)	4.2
Std. Deviation		380.7439	2.5054	52.0545	3.0530	5.8141
Range		1233.0	8.1	172.0	9.7	20.5
Minimum		119.0	2.1	67.0	4.4	4.2
Maximum		1352.0	10.2	239.0	14.1	24.7
Percentiles	25	336.000	3.900	125.000	7.100	5.500
	50	498.000	6.300	153.000	8.200	12.600
	75	826.000	8.600	182.000	11.400	13.300

a Multiple modes exist. The smallest value is shown

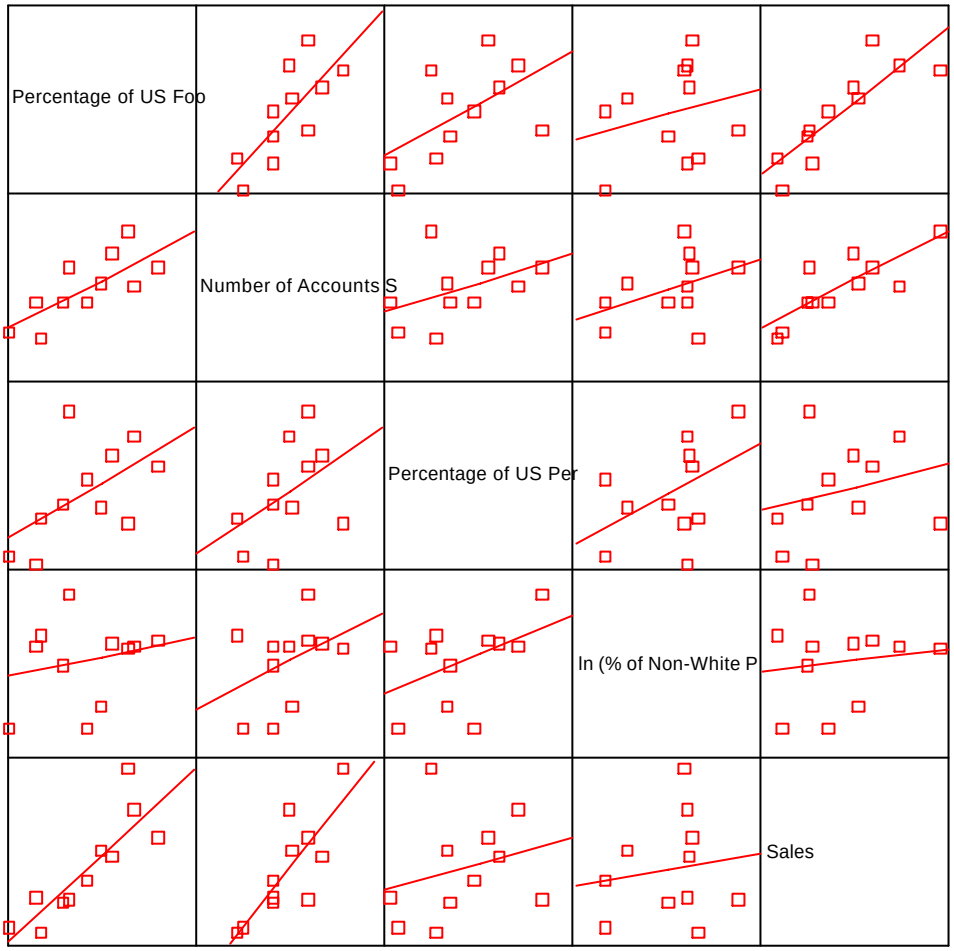
Histograms of the variables appear to have distributions that are approximately normal.



Scatterplot matrix using the original values of the variables.



Scatterplot matrix with X_4 transformed by taking its natural log.



(a) Using SPSS, the regression equation is:

Sales (in thousand dollars) = -218.05 + 129.67 (% of US footwear sales)

The regression is significant at the 0.001 (0.1%) level. A stepwise regression is used and independent variables X_2, X_3 and X_4 are found not to be significant and hence excluded from the regression equation.

Coefficients(a)

Model		Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
		B	Std. Error	Beta	t	Sig.	Tolerance	VIF
1	(Constant)	-218.054	175.740		-1.241	.246		
	X1 Percentage of US Footware	129.672	26.416	.853	4.909	.001	1.000	1.000

a Dependent Variable: Y Sales

(b) About 70% of the variation in sales among the territories is explained by the regression equation in (a) above based on the adjusted R^2 of 0.698.

Model Summary(b)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.853(a)	.728	.698	209.2867	1.157

a Predictors: (Constant), X1 Percentage of US Footware
b Dependent Variable: Y Sales

(c) Explanatory variable X_1 of percentage of US footwear sales is a significant variable at the 1% level as shown in the table in part (a).

The other variables are not significant at the 1% level as shown in the table below of excluded variables. Variable X_2, X_3, and X_4 are only significant at the 16%, 14% and 74% level respectively.

Excluded Variables (b)

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics		
						Tolerance	VIF	Minimum Tolerance
1	X2 Number of Accounts Services	.387(a)	1.567	.156	.485	.427	2.342	.427
	X3 Percentage of US Personal Income	-.320(a)	-1.663	.135	-.507	.681	1.468	.681
	X5 In (% of Non-White Pop)	-.067(a)	-.354	.733	-.124	.942	1.062	.942

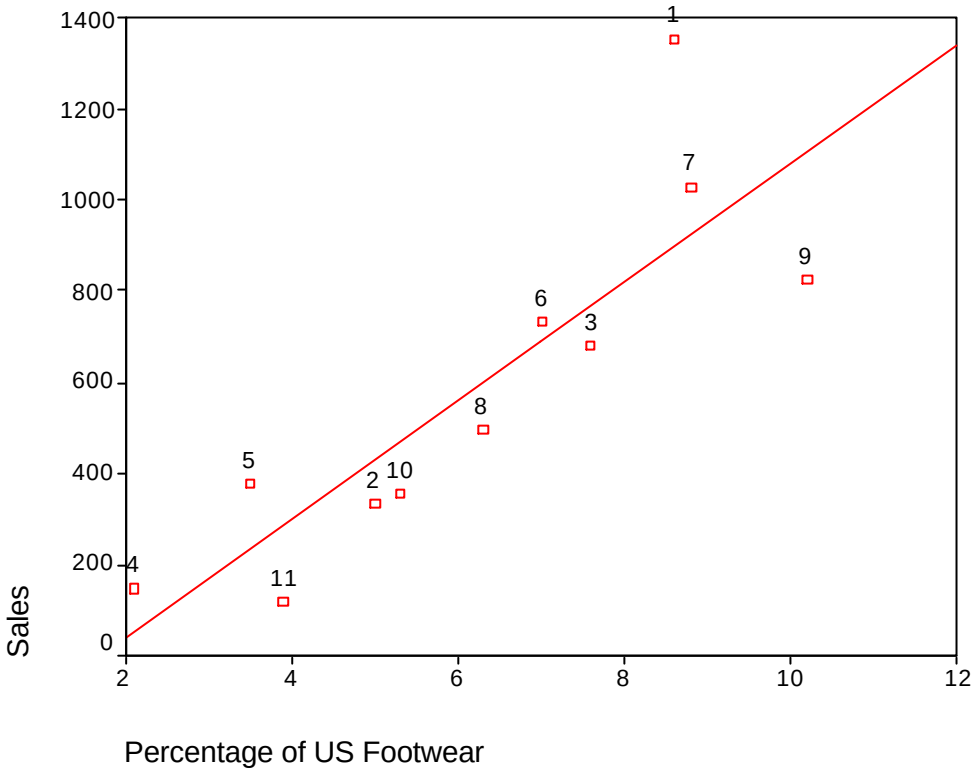
a Predictors in the Model: (Constant), X1 Percentage of US Footware
b Dependent Variable: Y Sales

(d) Using the regression equation in (a), an expected Y is computed for each territory in the table below.

a = -218.0541
b = 129.672

Territory	X_1	Actual Y	Expected Y	Deviations
1	8.6	1,352.0	897.1	454.9
2	5.0	336.0	430.3	(94.3)
3	7.6	682.0	767.5	(85.5)
4	2.1	147.0	54.3	92.7
5	3.5	378.0	235.8	142.2
6	7.0	732.0	689.6	42.4
7	8.8	1,031.0	923.1	107.9
8	6.3	498.0	598.9	(100.9)
9	10.2	826.0	1,104.6	(278.6)
10	5.3	357.0	469.2	(112.2)
11	3.9	119.0	287.7	(168.7)

The scatterplot below graphs the relationship between territory sales and the percentage of US footwear sales (X_1). While most of the actual sales are relatively close to the regression line, territory 1 is almost an outlier that is way above the expected sales. Territory 9 is also quite far below the regression line.



(e) Most of the actual observed sales are relatively close to the expected sales as predicted by the regression equation, as can be seen from the scatterplot in (d) above. The red line is the regression line, and most of the observed territory sales are slightly above or below the regression line in a random manner.

Observed sales of Territory 1 and Territory 9 appear to be farther away from the expected sales based on the regression equation. Territory 1 has about the same level of percentage of US footwear sales as Territory 7, but its observed sales is way above

the expected amount. Territory 9 has the highest level of percentage of US footwear sales, but its actual sales is drastically below expected sales based on the regression equation.

(f) We have performed a stepwise regression, and the only independent variable remaining in the regression equation is X_1, the percentage of US footwear sales of the territory. Based on the regression equation from (a) above, each percent change in the percentage of US footwear sales in the territory is positively related to a change in sales of $129,672. The other variables, X_2, X_3 and X_4, are found to be insignificant even at 10% level (see (b) above).

The table below shows the result of the regression analysis that has maintained all the variables in the analysis. This analysis is performed to ensure that variables X_2, X_3 and X_4 are not excluded incorrectly.

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	-115.177	253.197		-.455	.665	-734.727	504.373		
	X1 Percentage of US Footwear	107.905	38.228	.710	2.823	.030	14.365	201.445	.338	2.954
	X2 Number of Accounts Services	3.209	1.757	.439	1.826	.118	-1.091	7.508	.371	2.695
	X3 Percentage of US Personal Income	-38.326	24.342	-.307	-1.574	.166	-97.888	21.236	.562	1.779
	X5 In (% of Non-White Pop)	-43.148	120.592	-.063	-.358	.733	-338.226	251.929	.685	1.459

a. Dependent Variable: Y Sales

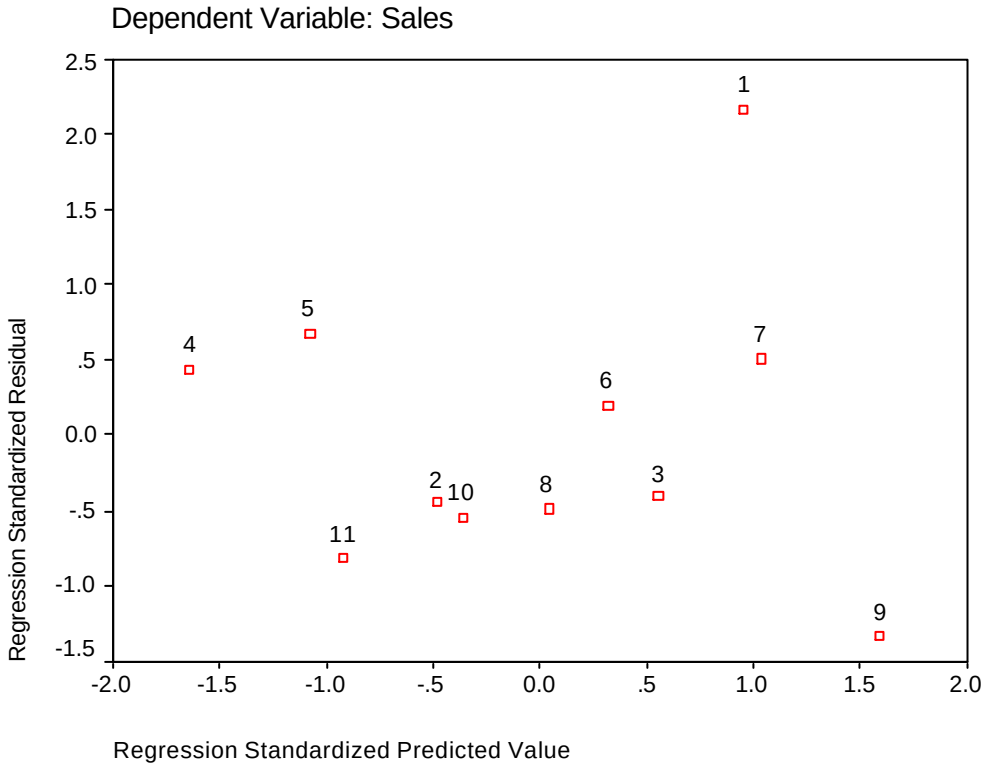
The regression equation based on this analysis is:

$$\text{Sales} = -115.177 + 107.905\, X_1 + 3.209\, X_2 - 38.326\, X_3 - 43.148\, X_4$$

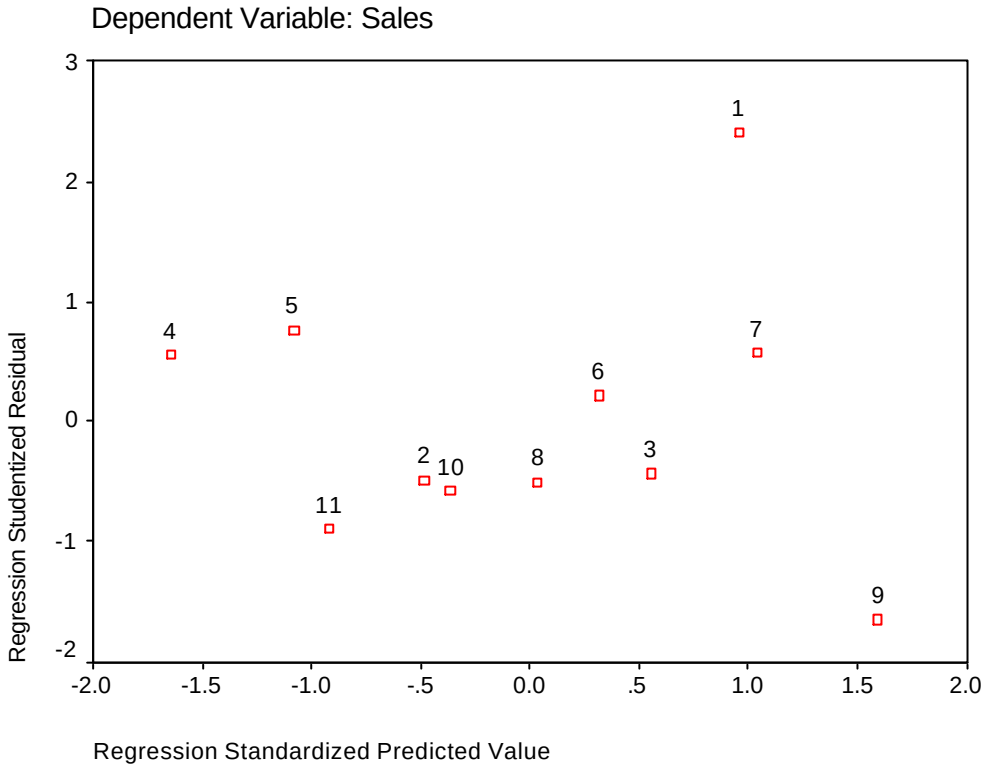
Based on this analysis and ignoring the level of significance of the independent variables, the effects of the independent variables are as follow:

	Independent Variables	Coefficients	Impact on Dependent Variable
X_1	Percentage of US footwear sales	107.905	A percentage increase in US footwear sales in the territory will increase expected sales by $107,905.
X_2	Number of accounts services	3.209	A percentage increase in the number of accounts services in a territory will increase expected sales by $3,209.
X_3	Percentage of US personal income	-38.325	A percentage increase in US personal income in the territory will reduce expected sales by $38,325.
X_4	Percentage of non-white population	-43.148	A percentage increase in non-white population in the territory will reduce expected sales by $43,148.

(g) The actual dollar value of the regression residuals are calculated in (d) above and are depicted as "Deviations" in the table. However, analysis and comparison of residuals are difficult due to different sales levels in absolute terms. To facilitate analysis, the residuals are standardized in the scatterplot below and the residuals appear to be random.



Since there are only 11 territories as sample points, the studentized residuals are plotted below and the studentized residuals appear to be random as well.



(h) Based on the residual scatterplots in (g) above, any territories that exceed or fall below the sales norm by greater than one S_e can be determined by observing for points above the +1 and below the -1 level on the regression residual scale. In both analysis, Territory 1 exceeds the sales norm by greater than one S_e and Territory 9 lags the sales norm by greater than one S_e.

4. The men's track records for 55 countries are provided. Records for 8 events are included: 100m, 200m, 400m, 800m, 1,500m, 5,000m, 10,000m, and Marathon. The unit of measurement is minutes for all events except for 100m, 200m and 400m which are in seconds. In order to obtain a consistent unit of measurement, all records in minutes are converted to seconds using the data transformation and compute feature of SPSS prior to the statistical analysis.

   To ensure that it is appropriate to use factor analysis, the anti-image correlation matrix, Bartlett test of sphericity, and measure of sampling adequacy tests are conducted. The anti-image correlation matrix table below indicates that all variables have relatively low anti-image correlations with the other variables, indicating that the data is not unsuitable for factor analysis.

Anti-image Matrices

		V1	V2	V3	V4S	V5S	V6S	V7S	V8S
Anti-image Covariance	V1	.123	-.085	-.046	-.008	.013	.008	-.010	.016
	V2	-.085	.112	-.009	-.008	-.018	-.008	.008	.002
	V3	-.046	-.009	.155	-.038	-.008	-.001	-.002	-.002
	V4S	-.008	-.008	-.038	.116	-.038	-.002	.002	-.012
	V5S	.013	-.018	-.008	-.038	.073	-.009	-.015	.009
	V6S	.008	-.008	-.001	-.002	-.009	.045	-.024	-.013
	V7S	-.010	.008	-.002	.002	-.015	-.024	.033	-.026
	V8S	.016	.002	-.002	-.012	.009	-.013	-.026	.095
Anti-image Correlation	V1	.836(a)	-.729	-.333	-.066	.133	.108	-.159	.149
	V2	-.729	.872(a)	-.071	-.071	-.200	-.109	.126	.021
	V3	-.333	-.071	.958(a)	-.285	-.072	-.015	-.029	-.014
	V4S	-.066	-.071	-.285	.947(a)	-.417	-.022	.031	-.109
	V5S	.133	-.200	-.072	-.417	.933(a)	-.156	-.309	.109
	V6S	.108	-.109	-.015	-.022	-.156	.914(a)	-.610	-.192
	V7S	-.159	.126	-.029	.031	-.309	-.610	.872(a)	-.466
	V8S	.149	.021	-.014	-.109	.109	-.192	-.466	.934(a)

a Measures of Sampling Adequacy(MSA)

   The Bartlett's test of sphericity indicates that the correlations among the variables are significant. The MSA index of 0.909 also indicates high correlations among the variables.

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.909
Bartlett's Test of Sphericity	Approx. Chi-Square	719.113
	df	28
	Sig.	.000

The first two principal components are required. Initially, the countries' location in terms of continents are coded and used as part of the factor analysis to determine if there is any relationship between geographical location of country and the records. However, it was found that the correlations are very low and we concluded that the geographical location of the country should not be used as part of the factor analysis. The correlation matrix of geographical location (V9C below) and the time records is provided below.

Correlation Matrix

		V1	V2	V3	V4S	V5S	V6S	V7S	V8S	V9C
Correlation	V1	1.000	.923	.841	.756	.700	.619	.633	.520	-.133
	V2	.923	1.000	.851	.807	.775	.695	.697	.596	-.239
	V3	.841	.851	1.000	.870	.835	.779	.787	.705	-.120
	V4S	.756	.807	.870	1.000	.918	.864	.869	.806	-.104
	V5S	.700	.775	.835	.918	1.000	.928	.935	.866	-.194
	V6S	.619	.695	.779	.864	.928	1.000	.975	.932	-.231
	V7S	.633	.697	.787	.869	.935	.975	1.000	.943	-.230
	V8S	.520	.596	.705	.806	.866	.932	.943	1.000	-.194
	V9C	-.133	-.239	-.120	-.104	-.194	-.231	-.230	-.194	1.000
Sig. (1-tailed)	V1		.000	.000	.000	.000	.000	.000	.000	.167
	V2	.000		.000	.000	.000	.000	.000	.000	.039
	V3	.000	.000		.000	.000	.000	.000	.000	.192
	V4S	.000	.000	.000		.000	.000	.000	.000	.224
	V5S	.000	.000	.000	.000		.000	.000	.000	.078
	V6S	.000	.000	.000	.000	.000		.000	.000	.045
	V7S	.000	.000	.000	.000	.000	.000		.000	.046
	V8S	.000	.000	.000	.000	.000	.000	.000		.078
	V9C	.167	.039	.192	.224	.078	.045	.046	.078	

Principal component analysis was performed to provide a general outline of the relationships. Factor analysis using the principal components approach results in one factor. As a result, the extraction methodology was changed so that 2 factors are extracted from the analysis. All the available extraction methodologies were performed

and the resulting factors are very similar. Output of the factor analysis using the principal components method is provided below.

Descriptive Statistics

	Mean	Std. Deviation	Analysis N
V1	10.4711	.35143	55
V2	20.9404	.64465	55
V3	46.4387	1.45702	55
V4S	107.5964	3.82109	55
V5S	221.8909	9.35456	55
V6S	830.7491	48.06963	55
V7S	1739.3455	108.46390	55
V8S	8197.4400	553.62201	55

Correlation Matrix

		V1	V2	V3	V4S	V5S	V6S	V7S	V8S
Correlation	V1	1.000	.923	.841	.756	.700	.619	.633	.520
	V2	.923	1.000	.851	.807	.775	.695	.697	.596
	V3	.841	.851	1.000	.870	.835	.779	.787	.705
	V4S	.756	.807	.870	1.000	.918	.864	.869	.806
	V5S	.700	.775	.835	.918	1.000	.928	.935	.866
	V6S	.619	.695	.779	.864	.928	1.000	.975	.932
	V7S	.633	.697	.787	.869	.935	.975	1.000	.943
	V8S	.520	.596	.705	.806	.866	.932	.943	1.000
Sig. (1-tailed)	V1		.000	.000	.000	.000	.000	.000	.000
	V2	.000		.000	.000	.000	.000	.000	.000
	V3	.000	.000		.000	.000	.000	.000	.000
	V4S	.000	.000	.000		.000	.000	.000	.000
	V5S	.000	.000	.000	.000		.000	.000	.000
	V6S	.000	.000	.000	.000	.000		.000	.000
	V7S	.000	.000	.000	.000	.000	.000		.000
	V8S	.000	.000	.000	.000	.000	.000	.000	

Communalities

	Initial	Extraction
V1	1.000	.950
V2	1.000	.939
V3	1.000	.892
V4S	1.000	.900
V5S	1.000	.938
V6S	1.000	.965
V7S	1.000	.973
V8S	1.000	.943

Extraction Method: Principal Component Analysis.

Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	6.622	82.777	82.777	6.622	82.777	82.777	4.186	52.323	52.323
2	.878	10.970	93.747	.878	10.970	93.747	3.314	41.424	93.747
3	.159	1.992	95.739						
4	.124	1.551	97.289						
5	.080	.999	98.288						
6	.068	.850	99.137						
7	.046	.580	99.717						
8	.023	.283	100.000						

Extraction Method: Principal Component Analysis.

Component Matrix(a)

	Component	
	1	2
V1	.817	.531
V2	.867	.432
V3	.915	
V4S	.949	
V5S	.959	
V6S	.938	
V7S	.944	
V8S	.880	-.411

Extraction Method: Principal Component Analysis.
a 2 components extracted.

Rotated Component Matrix(a)

	Component	
	1	2
V1		.935
V2		.893
V3	.543	.773
V4S	.712	.627
V5S	.813	.525
V6S	.902	
V7S	.903	
V8S	.936	

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.
a Rotation converged in 3 iterations.

Component Transformation Matrix

Component	1	2
1	.759	.651
2	-.651	.759

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.

Based on the results of the factor analysis using principal components method, the two factors that are derived can be classified as "Sprints" and "Runs." "Sprints" includes the events of 100m, 200m and 400m (variables V1, V2 and V3 respectively). "Runs" includes the events of 800m, 1,500m, 5,000m, 10,000m and the Marathon (variables V4S, V5S, V6S, V7S and V8S respectively). The distance of the race is the major difference between these two factors identified.

The two factors "Sprints" and "Runs" can be interpreted as categories of one criterion by which the results can be classified into meaning representations. For example, the time required for Sprints are generally under one minute while Runs take over one minutes. There are also strategic differences in that runners run as fast as they can in Sprints but runners might utilize strategic positioning during the race in Runs.