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RESEARCH PAPER

Statistical Tools in Social Science Research: Applications and Interpretations

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ABSTRACT

This paper investigates the role of statistical tools and techniques in social science research. The objective of the study is to explore the use and application of statistical tools and procedures and to provide a base for further research in social science. The study presents brief overview of the statistical tools along with its assumptions. It provides evidence from literature of social sciences which have extensive use of statistical tools and techniques. A large number of the research work in world leading research journal speak itself the application of the statistical tools and procedures. Most of the social science subjects specially psychology, management, sociology and economics have got immensely benefit from the use of statistical tool.

Introduction

The All modern sciences including social sciences are founded on the state of the art research in their respective domains and scientific methodology is the hallmark of research in any field of science. Scientific methodology stipulates rigorous research design and is based on inferences drawn from quantifiable and verifiable data through valid and reliable statistical tools rather than explanations based subjective experiences and knowledge of individuals. Although, some of the key works in social sciences have not used any statistical tools, nonetheless the social sciences are increasingly relying on statistical tools and techniques. Keeping in view the importance of statistics for social sciences, Antoniasmy et al. (2010) commented that in recent years, statistics found popular applications in the field of social sciences such as economics, political science, law, sociology and anthropology. Statistical tools, such as sampling, time-series analysis, index numbers, correlation and regression analyses, approaches of statistical inference such as estimation and hypothesis testing of relationship empirically for many economic variables such as wages, prices, production and income and wealth distribution etc. In addition, advanced methods of statistics like multi-level models, structure equation modeling and survey methods have been extensively used in various branches of social sciences"

Accurate, reliable and valid data are most important for valid inferences but data itself are useless and mute untill processed through some statistical tools. Similarly right kind of statistical tools, with all its assumptions properly met, is equally important for valid generalizations. Therefore statistics have key role in social sciences and no social scientist can survive without reasonable understanding of basic statistical concepts.

Literature Review

Pallant (2004) stated that statistical tests can be categorized in many ways and generally they are based on the types of measurement of variables used and associated in research design. Generally they are known as parametric tests or methods, using interval and ratio scale data and non-parametric test or methods using nominal and ordinal scale data. Every statistical test has underlying assumptions which must be met before its use. To simplify the things, statistical techniques can be broadly classified into two classes. First contains the set of techniques which are used to explore relationship among variables and second contains techniques used to compare groups based on some standard statistical measures. First group comprises of Correlation, partial correlation, regression and multiple regression and multivariate statistical analysis. Second group comprises of statistical testing procedures like independent sample test, paired sample t-test, Analysis of variance (one way-ANOVA) and repeated measure ANOVA. The following tables summarizes the statistical techniques both for exploring relationship among variables and comparing groups along with their uses for various purposes

Table 1
Statistical Techniques for Exploring Relationship between variable(s)

Correlation	Used with pairs of normally distributed continuous variables. It shows strength of relationship between the two continues variables (Pearson's correlation coefficient)
Partial correlation	Same as above except adjustment is made for other variables e.g. Age or gender etc.
Regression	It produces an equation with the help of which value of dependent variable Y can be predicted for change in independent variable X using straight line equation.
Multiple regression	Same as above except the number of independent variable are many and we check for the impact of all the independent variables.
Factor Analysis	Used mostly for reducing data to get a small number of preferably uncorrelated variables from a large number of variables

Table 2
Statistical Techniques for Comparison of groups

Independent sample t-test	Used for equality of means between two groups for single measurement of the dependent variable and tells you if the two means differ?
Paired sample t-test	Used for single group measured for some dependent ratio variable twice to check whether the first measurement differ from the second.
Analysis of variance (ANOVA)	Used for three or more groups and measured once for dependent variable to check if groups means are different from the other means.
Repeated measures ANOVA	same as ANOVA except the dependent variable is measured twice and groups initial means and final means are compared for variances.

Non-parametric tests are based on categorical/nominal, ranked or ordered data. These tests can be used with small sample sizes in groups and they do not have stringent assumptions of parametric tests. The following tables summarizes the non-parametric tests and their uses

Table 3
List of Important Non-Parametric Tests

Chi-square goodness of fit	Used to check if sample frequencies are similar to population's frequencies
Chi-square test of independence	Used to check if relationship between variables exists or not?
Spearman's rank order correlation	Used for checking association/relationship between two ordinal (rank ordered) variables. This is the non-parametric equivalent of Pearson's correlation.
Kendall's Tau	Same as the Spearman but is best if sample size is ten or fewer subjects.
Mann-Whitney U-test	Non-parametric counterpart of the Independent sample t-test
Kruskal-Wallis H test	Non-parametric counterpart of the ANOVA.

Nancy et al., (2005) argued that fulfilling 0f assumptions or constraints on the different procedures of statistics works as the directions for the appropriateness of the statistical methods given in the manual of owner. These are the restriction which help the researchers whether a particular approach of statistics is sound enough at a particular situation. They further stressed that if assumptions of the tests not fulfill, the statistic calculated by SPSS informs the researcher about the significance or non-significance of results, may lead to draw the wrong conclusions. Parametric tests are t-tests, analysis of variance (ANOVA) and Pearson correlation etc.

Argyrous (2000) stated that parametric tests are for those data set which contain certain statistical features including assumptions of independence of data, normality of probability distribution of variables, homogeneity of variances and linear relationship. These assumptions should be met before applying these tests. The researcher found that many parametric approaches of statistics are robust in nature. He interpret the robust as the violation of the assumption without effecting the validity of test statistics. e.g. In application of ANOVA, it is assumed that the response variable must behave independently and identically distributed normally for each group. But many statistician proposed that even the data is not completely normal, one can used this methodology

Whereas nonparametric statistical approaches like chi-square test, Mann-Whitney U test, Kruskal Wallis H test, Kendal tau, Spearman rho test of correlation coefficient etc. have few assumptions in comparison of parametric approaches and frequently used when the statistical restriction of a parametric test are not fulfilled. E.g. these approaches not required any normality of variables or equality and homogeneity of variances.

Micceri (1989) studied that most of univariate data in behavioral sciences do not required any normality assumption of variables. Breckler (1990) after reviewing 72 research papers in psychology concluded that merely 19% had tested data for the assumption of multivariate normal distribution, and about 10% considered the violation of this assumption.

Keselman et al., (1998), after reviewing articles in seventeen social sciences journals found that researchers seldom check the data for satisfaction of assumptions. They also concluded that generally used analyses were those not robust to the violation of assumption. Glass et al., (1972) demonstrated in his finding that violation of assumptions does not seriously damage results of many parametric approaches of statistics.

Experts disagree on what course of action to follow if data do not meet assumptions mentioned above. Non-parametric tests can be used or data may be transformed to normalization process to legitimize the use of these tests. However non-parametric tests

are criticized for different reasons. First, non-parametric approaches do not make any strong assumption regarding the population parameters or the shape of distribution. It is difficult to draw inference about the precision of the estimates. Edgington in 1995 discussed that when other alternatives procedures are available, it would be risky to compromise on precision of the estimates by altering the data into ranked.

Generally, perception of researchers is that power of non-parametric tests is less as compare to their parametric counterpart with certain exceptions. (Freidlin & Gastwirth, 2000, Hodges & Lehmann, 1956; Tanizaki, 1997). There is notion that non-parametric tests are different in the presence of outliers. Zimmerman (2000) asserted that Mann Whitney U-test and the Kruskal Wallis-H tests test are significantly biased due to unequal variances even when size are same in two samples. The presence of outliers is also detrimental to non-parametric tests. Also very few statistical software except MINITAB, STATA and SPSS can produce confidence intervals for non-parametric tests. Non-parametric tests are criticized and considered as being incapable of answering the questions like "Is Mann Whitney U procedure tests whether the two distributions are different in some respect? Although it does not show how they differ in shape, mean, or variance.

Thompson and Barber (2000) asserted that it has been now generally accepted that use of non-parametric tests may arrive at misleading conclusions. Based on these limitations, Johnson (1995) preferred other robust procedures and data transformation to than using non-parametric tests.

Numerous Uses of Statistical Techniques in Different Subjects

Boshoff (2003) used statistical tools Principal Factor Analysis with Direct Quartimin rotation, Pearson Product-Moment Correlation and Stepwise Multiple Regression using SAS-program (SAS Institute, 1996) for the prediction of job involvement among pharmacists and accountants. Wilkerson & Kim (2010) used factor analysis and t-test in their research on teacher's involvement with children's parents. Lata & Wohab (2010) used descriptive statistics and chi-square test for deprivation of people from different perspectives e.g Age, education, expenditure etc.

Loya *(*2011) used descriptive statistics, repeated measure ANOVA for the study of Transformational Effects of Service-Learning in a University Developed Community-Based Agency**.** Robert (2007) used ordinary least square regression method, Pearson correlation R and R^2 for job satisfaction, organizational commitment, job involvement, work motivation, culture of organization. Davis, Bagozzi, and Warshaw (1992) used Pearson correlation and regression analysis for Extrinsic and Intrinsic Motivation of employees to use Computers in the Workplace.

Christensen (1992) used correlation for exploring the limits of the technology curve. Haroon & Rehman (2011) used descriptive statistics for impact of Food Advertisement on Television on Children's Food Purchasing Behavior in Pakistan. Ramsey et al., (2011) used confirmatory factor analysis and other parametric tests for Evaluation of a Measure of Job Involvement among Salespeople. Chin-Chih (2006) used General Linear Model, Structured Equation Modeling, Pearson Correlation and descriptive statistics in his thesis on the Relationships between Work Values, Job Involvement and Organizational Commitment among Taiwanese nurses.

Peterson (2011) used ANOVA and correlation analysis to study his MBA students. Selamat (2011) Used regression analysis and factor analysis for measurement of Information Technology acceptance in Malaysian Bankers. Begg and Henry (1998) used regression analysis and time series techniques for forecasting economic data and its impact on public policy issues in United Kingdom. Bajtelsmit and Bernasek (1996) performed

correlation and multiple regressions analysis of how women invest differently from men. Azad and Hamdavipour (2011) used t-tests in their research on effects of packaging characteristics on consumer's purchasing confidence. Analysis of Variance (ANOVA) continues to be widely used in social science research to assess differences between group means. Its applications have extended beyond conventional experimental designs to encompass quasi-experimental and observational studies (Maxwell et al., 2018). Moreover, the ability of ANOVA to incorporate multiple comparison procedures has increased its applicability across a broad range of research settings (Haans, 2018). Wasserstein et al. (2019) highlight the need to apply statistical methods judiciously, taking into account their underlying assumptions and the specific research context. Likewise, Greenland et al. (2016) stress the importance of recognizing the limitations and constraints of statistical techniques to ensure accurate interpretation of research findings. The Chi-square test has long been used to investigate associations between categorical variables. Its applications have broadened to include goodness-of-fit testing, model fit evaluation, and the analysis of contingency tables (Agresti, 2019). The significance of this study lies in its potential to enhance methodological rigor in social science research by facilitating informed decisions regarding statistical analysis. As noted by Hair et al. (2019), inappropriate statistical techniques can lead to erroneous conclusions, undermining the credibility of research findings.

Conclusion

Literature review highlighted the importance and respected status of statistical tools and techniques among social sciences researchers. A large number of research works in world leading journals speak for itself the application and use of statistical methods and procedures. Most of the social sciences subjects, particularly Psychology, Management and Economics, have immensely benefited from the use statistical tools and methods. In other subjects statistics somewhere adds significant meanings to the results and in some cases the research will have no value without the use of statistical techniques at all. Moreover Statistics have given causal direction to subjects where initially explanatory studies were considered thereby digging into the root causes of the problems. Therefore social scientists must consider more and more use of sophisticated statistical techniques to draw more meanings and accurate conclusions in confident fashion. However the validity of inference drawn from these statistical techniques rely heavily on its correct application and with its proper assumptions.

Recommendations

Future research should focus on evaluating the appropriateness and effectiveness of statistical tools across different fields of social science research. Researchers should give greater attention to verifying the assumptions of statistical techniques before applying them to ensure the validity and reliability of findings. Further studies may compare traditional statistical methods with advanced analytical approaches to identify their relative strengths and limitations. Emphasis should also be placed on improving researchers' understanding of statistical results and avoiding misinterpretation of p-values, confidence intervals, and effect sizes. The integration of statistical software and emerging data analysis techniques should be explored to enhance analytical accuracy and efficiency. Moreover, research should investigate the common statistical errors made by social science researchers and recommend practical strategies for addressing them. Finally, the development of methodological guidelines and targeted statistical training programs may promote the responsible application and interpretation of statistical tools in social science research.

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